COMMERCIAL RAW MATERIALS

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Commercial Raw Materials

THE COTTON PLANT AND ITS PRODUCTS

A SERIES FOR SCHOOL USE

COMMERCIAL RAW MATERIALS

Their Origin, Preparation and Uses

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PREFACE

The Philadelphia Museums are sending to the public schools of Pennsylvania a series of collections of commercial products, charts, maps and photographs illustrating the commerce of the world and designed as an aid to the teaching of commercial geography and natural science. The distribution is made under state appropriations. The collections have been graded according to the work done in the different schools, and different series are furnished for primary and secondary schools, regular high schools and commercial high schools. The standard collection comprises twenty-five maps of commercial distribution, over one hundred economic photographs and over three hundred commercial products. This book was prepared primarily as a work of reference for the schools in connection with the use of these collections.

A consideration of the nature and uses of the materials, which are of economic importance and on which the business of the world and the life of its people are dependent, is a necessary part of the study of geography or commerce. Until recent years no schools in this country have systematically taken up the study of the products of the world, although courses along this line are essential parts of the curricula in many schools in Europe.

This book, which is briefly descriptive of the origin, processes of preparation and uses of the most important commercial materials, will, it is hoped, aid teachers in all grades whether they take up the products in a special course or only refer to them in connection with the countries which produce them.

No classification of materials has yet been devised which is not open to some criticism. The grouping adopted here is into substances of vegetable, animal and mineral origin. The plants first described yield foods or food accessories; following these are plants, such as the cocoanut, which yield both food and fiber; and then those, like the cotton plant, which supply fiber, oil and cattle food. All of the materials obtained from one plant are grouped together. The same subdivision is used as far as possible with substances of animal and mineral origin. This classification is generally found more convenient and better than the separation of the many different products which may come from one source.

The maps of distribution show by their shading the parts of the world which produce the largest amounts of the various articles. The preparation of similar maps and charts showing the amount and relative importance of the materials produced, consumed, exported or imported will be found helpful to the student.

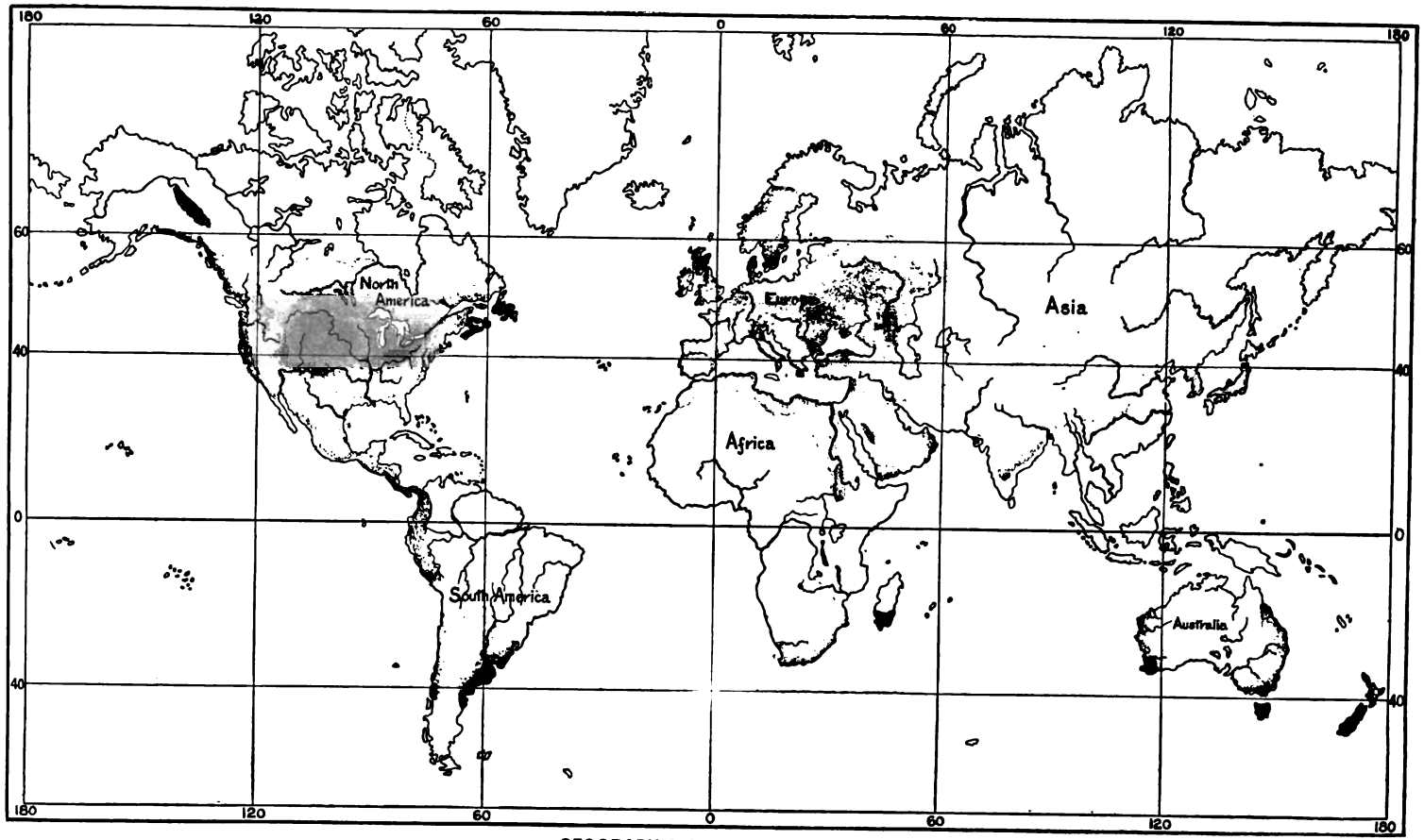
It is very desirable to use specimens in the class-room, in order to make the study of the world's products clear and profitable. It is of great importance for every school to accumulate its own collection or museum, and much can be accomplished by the pupils as original work in the course of their studies. Specimens of many of the world's products are easily obtained by anyone. Teachers and children can get samples of many articles from merchants and manufacturers, who are usually glad to aid in the cause of education.

Helpful pictures illustrative of such subjects as agriculture, lumbering, fishing, mining, manufacturing in different lines, or transportation in connection with the products of various countries, are published from time to time in many magazines.

It is important that specimens in a school museum be carefully and accurately labelled, and that they be classified and preserved in such a way that they can be easily taken to the class-room, used and returned to their places.

The author has had unusual opportunities to become familiar with the things which make up the commerce of the world, through close contact with the Museums' collections. He is indebted to Mr. S. F. Aaron and Dr. B. H. A. Groth, former members of the staff of the Museums, for valuable assistance throughout the work, as well as to Dr. William P. Wilson, Director of the Museums, for his helpful suggestions and good advice.

Free use has, of course, been made of many standard works of reference in compiling information.



GEOGRAPHIC DISTRIBUTION OF

WHEAT

VEGETABLE PRODUCTS.

FOODS.

In most countries there is one foodstuff which, above all others, is considered the standard food, a food which the rich and poor eat alike. In the northern part of the United States and in the northwest of Europe this is wheat bread; in northeastern Europe it is rye bread; in parts of Ireland, potatoes; in Mexico, "frijoles" and maize; in southeastern Asia, rice; in many tropical islands, almost exclusively fruits such as the banana or the cocoanut. Usually the foods mentioned are the principal products of the respective countries. There are cases, however, where foreign transportation is so cheap that it furnishes a country with an imported standard food, as happens when salted fish are sent from New England and Canada to some of the West India Islands. Besides the standard and more important foods, there are everywhere many others of more or less importance: beverages, spices, fruits, etc. It is impossible to distinguish strictly between important foods and luxuries, for in Venezuela, for example, wheat flour is as much a luxury as pineapples are in Pennsylvania.

Articles of Vegetable Origin Used as Food.

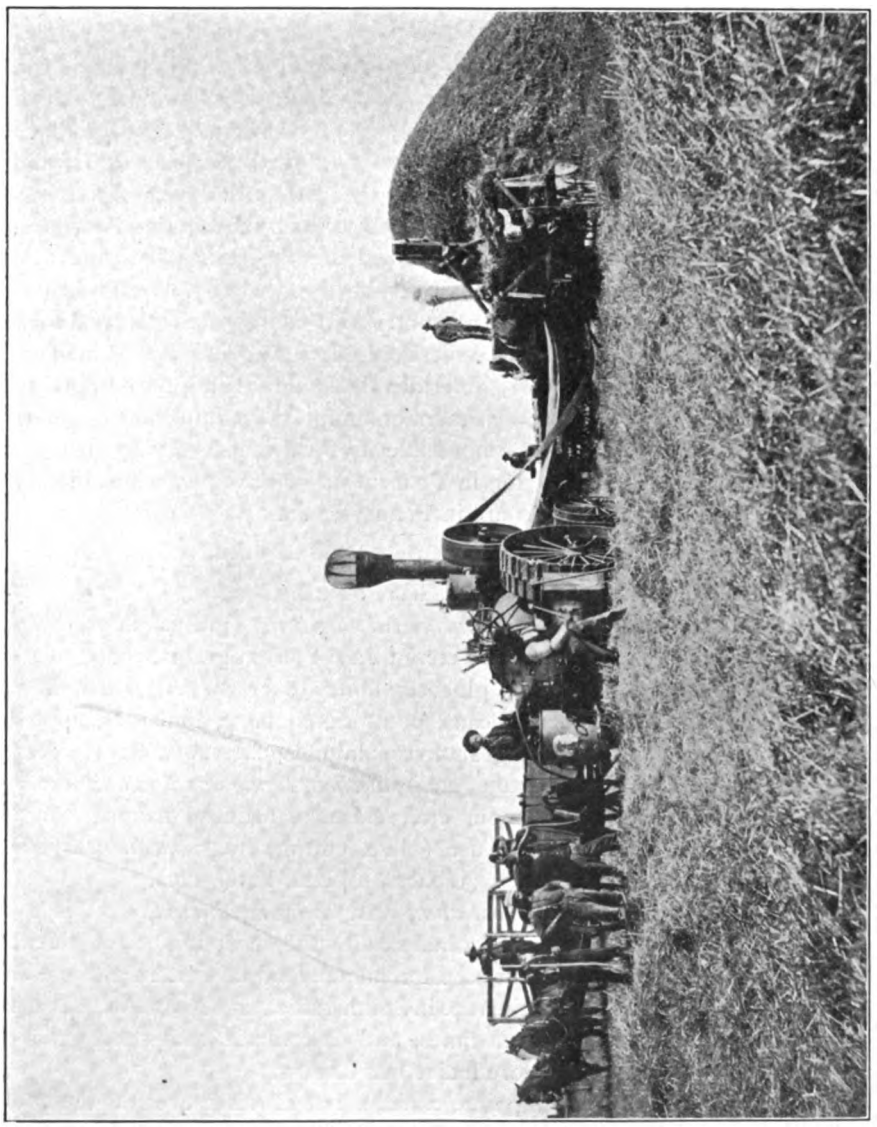
For animal food: grains, fodder, hay, oil-cake, etc.

For human food: cereals, and cereal products (grains, flour, bran, oatmeal, breakfast foods, macaroni, etc.); *starch* (from grains, roots, etc.); *sugar* (cane sugar, beet sugar, glucose, honey); *vegetables, fruits, nuts,* fresh dried or preserved (peas, beans, potatoes, cabbage, tomatoes, apples, berries, grapes, pineapples, oranges, olives, almonds, chestnuts, etc.); *beverages* (tea, coffee, chocolate, postum, etc.); *alcoholic liquors; spices and flavors* (pepper, ginger, cloves, cinnamon, etc., extracts, artificial flavors, condiments); *vegetable oils,* for table use (olive, cotton, etc.); *medicines* (quinine, castor oil, etc.); *stimulants* (tobacco, opium, betel, etc).

WHEAT

Wheat (*Triticum sativum*, var. *vulgare, durum, etc.*) is the most nutritious, and commercially the most important cereal. It is the chief grain used for human food in western Europe, in North America, and by the white race in South Africa and Australia. It has been cultivated since very ancient times, and, in common with other grains, was referred to as "corn" before maize was known.

Wheat thrives best in temperate climates but is raised even in the cool mountainous regions of the tropics. The United States is the greatest wheat producing country because of favorable climate and soil, the use of improved agricultural machinery, and economical methods of handling and transportation. Wheat is handled in the United States largely in bulk; it is loaded loose (not in bags), on cars or in boats, transferred by machinery



THRESHING WHEAT, MINNESOTA

and stored in grain elevators. In other countries the grain is usually stored in bags and the cost of handling is, therefore, considerably greater. The European countries are all large producers of wheat, but only Russia and Hungary grow more than they need at home. The others must import it from them, or from the United States, India, Australia, or Argentina.

Wheat is classified commercially as "hard" or "soft." The hard varieties contain a large percentage of gluten or protein, and are suitable for making such foods as macaroni. Soft wheats contain more starch and are used for making flour. Some flours are made of a mixture of hard and soft wheats. Wheats are also classified according to their color, "red" or "white," and according to their season, "winter" or "spring." Winter wheats are sown in autumn and harvested in early summer; spring wheats are sown in the spring and harvested in late summer. The same wheat may be cultivated as a winter or spring variety, but when grown for generations as winter wheat it does not thrive as spring wheat and vice versa. Like many other cultivated plants, wheat has developed hundreds of varieties, known to growers under different names.

Wheat is ground in great mills where heavy steel rollers have taken the place of the old style millstones. After grinding, it is separated by sieves and bolting cloth into bran, middlings and flour of different degrees of fineness. Minneapolis is the centre of the milling industry. Grits, starch, and breakfast foods are also made of wheat. Wheat straw is plaited for hat making. Leghorn braids are made in Italy from the stalks of wheat, gathered while green and bleached in the sun.

BARLEY Barley (*Hordeum sativum*, var. *vulgare, etc.*) is chiefly used for beer brewing and in some places as horse feed. It is cultivated in north and central Europe, as far as northern Norway; in Tibet, northern China, Japan, and to a limited extent in the United States. In warmer countries it thrives only in the mountains.

For household use, pearl barley is used in preparing soups, gruels, etc. In Scandinavia, barley flour is used for making bread.

Malt is made from barley (or sometimes from other grains) by spreading it, wet, on the floor of a dark room where it swells and sprouts. It is then dried, screened, ground up, boiled with hops, and allowed to ferment to make beer. During the process of sprouting, or germination, a ferment, diastase, is produced, which converts the starch of the grain into dextrine and maltose. Maltose is a kind of sugar and this, in fermentation, produces alcohol.

RYE Rye (*Secale cereale*) is the chief breadstuff in Russia, Scandinavia and parts of Germany. It is cultivated like wheat, in "winter" and "spring" varieties, and grows in a colder climate and on poorer soil than wheat. Rye is one of the grains used in the United States for making whiskey. In Russia, "vodka" is made from it. Rye straw is long and tough and is used for making braids for hats, and to a less extent for making ropes and mats, and, by the poor people in parts of Europe, for

thatching. Russia is the greatest producer of rye. The United States furnishes only a very small part of the world's production.

OATS Oats (*Avena sativa*) is most important as horse feed. As oatmeal it is used for human food in Scotland, Ireland and other countries. It flourishes in a cooler and moister climate than wheat, and is grown over a large area. In this country, Illinois and Iowa are the greatest oat producing States. In Europe it grows most largely near the Baltic coasts of Russia and Germany and in Ireland, Scotland, France, Austria-Hungary and Norway. Russia and the United States grow more oats than other countries.

MAIZE Maize or Indian Corn (*Zea mays*) is largely used as a food for live stock, the bulk of the crop being used in the West for this purpose. The principal corn producing States are Illinois, Iowa, Nebraska, Kansas, Missouri, Indiana and Ohio. It is the most important human food in some sections of the southern United States, in Mexico, Central America, and in parts of Italy and Egypt. In Europe, maize is little cultivated and the name "corn" is applied to wheat, oats, and other grains.

There are many varieties of maize varying in size, color, and composition ; some are rich in starch and others in oil. The numerous varieties are due partly to the influence of soil and climate and partly to the efforts of the growers to develop certain characteristics, such as the large or small percentage of starch. Two types are distinct from all others, sweet or sugar corn, and pop-corn ; these are grown in relatively small quantities compared with the total production of corn, and are used entirely for human food.

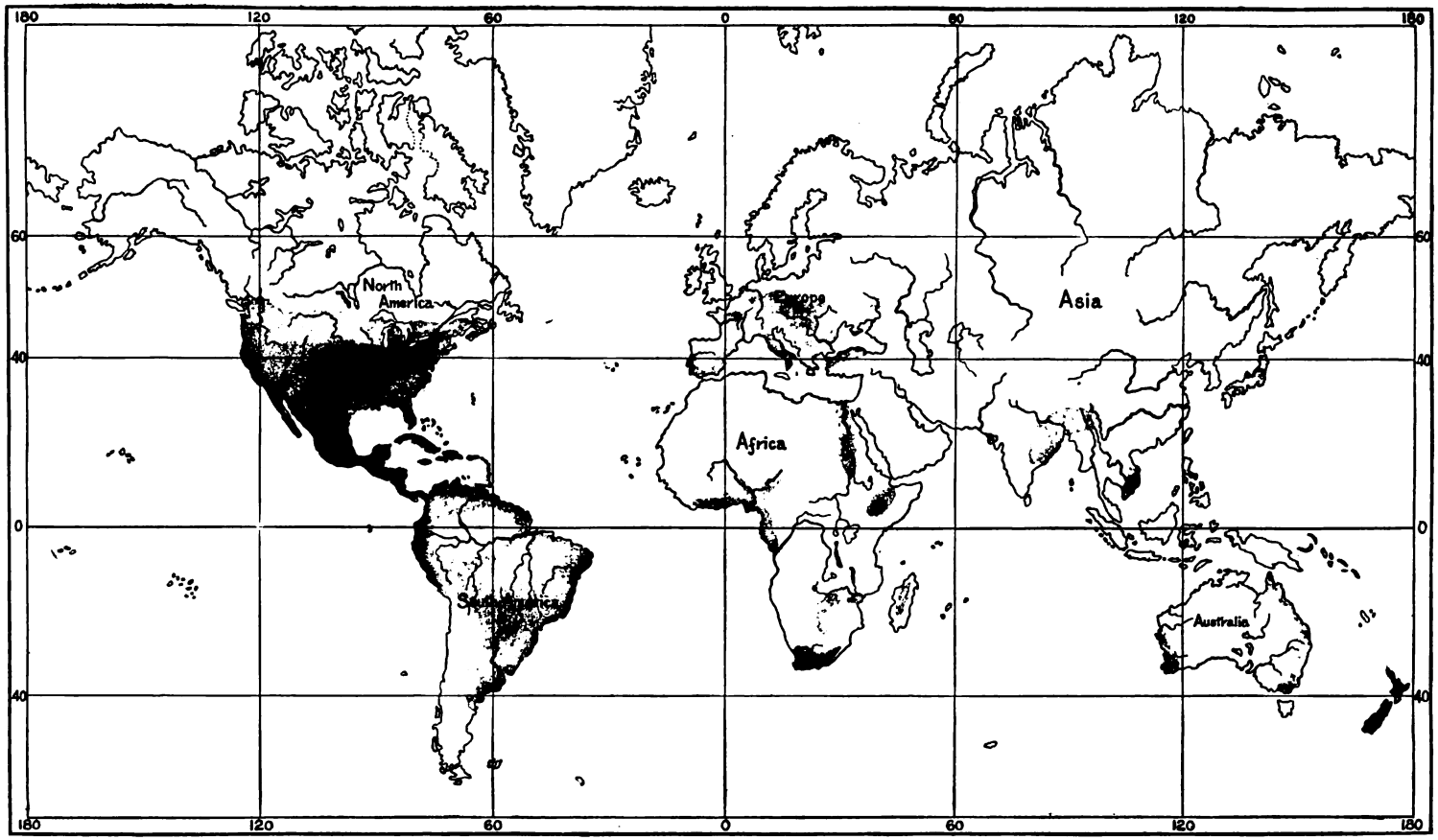
(For Corn Starch, see Starch, also Glucose, and Grape Sugar.)

During the process of starch making the germs of the corn are separated. These are placed in coarse cloths and pressed by machinery, until the oil is extracted. The material remaining, called oil-cake, is used for cattle food, and the oil is useful for soap making, lubricating, burning, and as a substitute for linseed oil in paints. Corn oil can be vulcanized (see Rubber) and then forms a substitute and adulterant for rubber. The actual value of corn oil is greater than the value of the starch itself, extracted from maize. Corn pith is used for packing between the double hulls of ships, because when it absorbs water it swells up and thus closes a hole made by a cannon ball.

(See diagram of the Corn Plant on page 5.)

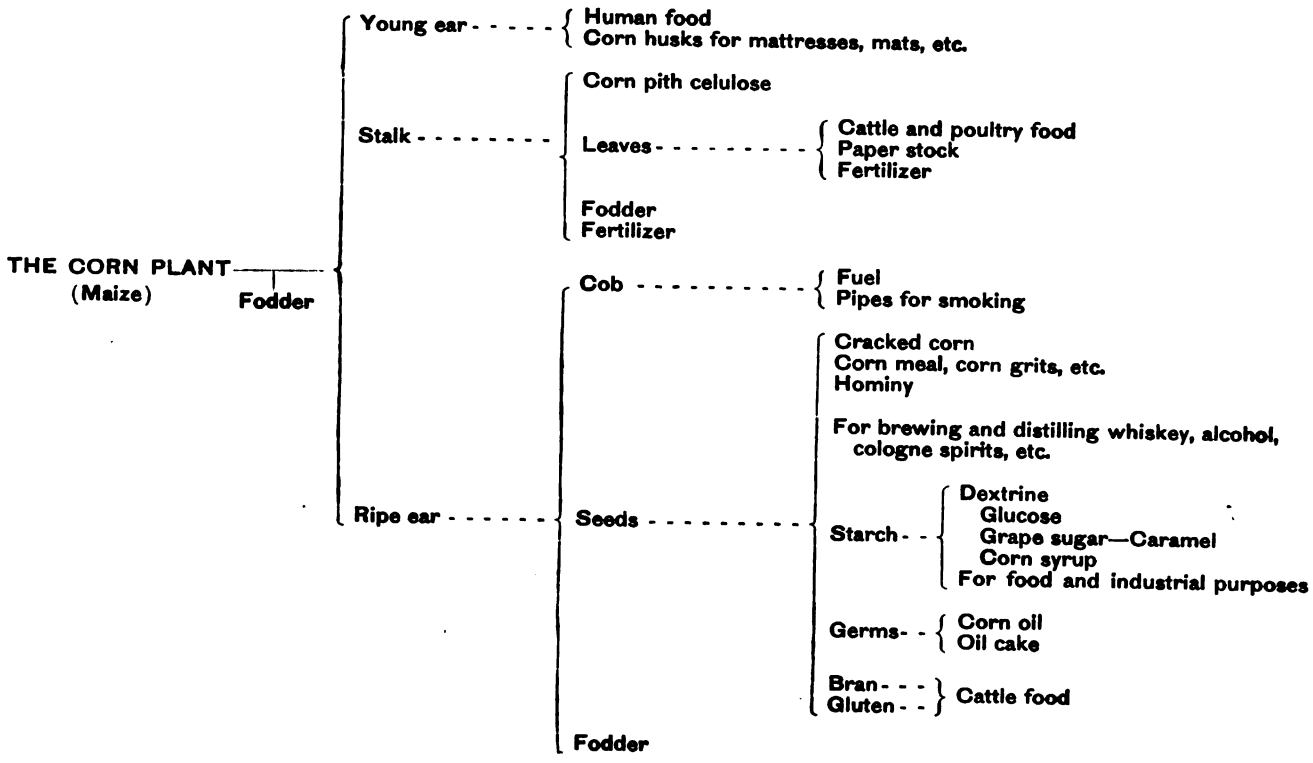
RICE Rice (*Oryza sativa*) is the principal food of one third of the people of the world. It is not so important as some other grains in general commerce, because it is largely consumed in the countries which produce it. It is the principal crop and the main food in southeastern Asia from India to southern Japan and in many of the islands of the Pacific. The United States prod ıces in the southern states, chiefly Texas, Louisiana and South Carolina, about half as much rice as it consumes, importing the remainder from eastern Asia.

There are several important kinds in cultivation: common rice, swamp rice, upland rice, and glutinous rice, besides several hundred minor varieties.



GEOGRAPHIC DISTRIBUTION OF

INDIAN CORN OR MAIZE



The crop is dependent upon a bountiful supply of moisture and a warmer climate than is necessary for other grains. It is grown in swampy places or else in fields which can be kept flooded during the period of growth. Extensive irrigation has made it possible to grow rice successfully on the prairies of Louisiana and Texas.

Rice with the hull on is called "paddy." After the hulls are removed by rapidly revolving millstones, the grains are polished or whitened by machinery. The grains which are broken in cleaning, although they contain just as much nutriment as the whole grains, sell at a very much lower price. The hulls are sometimes used as a packing material, or for fuel in the factory, and the rice flour or "polish" is a valuable by-product used for cattle food. Rice is richer in starch than any other cereal; the starch is extracted in much the same manner as from other grains (see Starch). Rice is used by the Japanese in brewing their national drink, a beverage called "saké." Rice paper (so called) is not made of rice but from the pith of an entirely different plant, although paper is sometimes made of rice straw. The straw is used in Japan and China for making mats, ropes, bags, sandals, rain coats, and other articles, and for thatching and bedding.

BUCKWHEAT

Buckwheat (*Fagopyrum esculentum*) although not a member of the family of grasses, is usually regarded as a cereal because its seeds are used like those of wheat, rye, and other grains. It is used for feeding poultry and for making flour for buckwheat cakes. In this country, New York and Pennsylvania produce two thirds of the crop. It is cultivated in Russia, France, and Japan.

MILLET

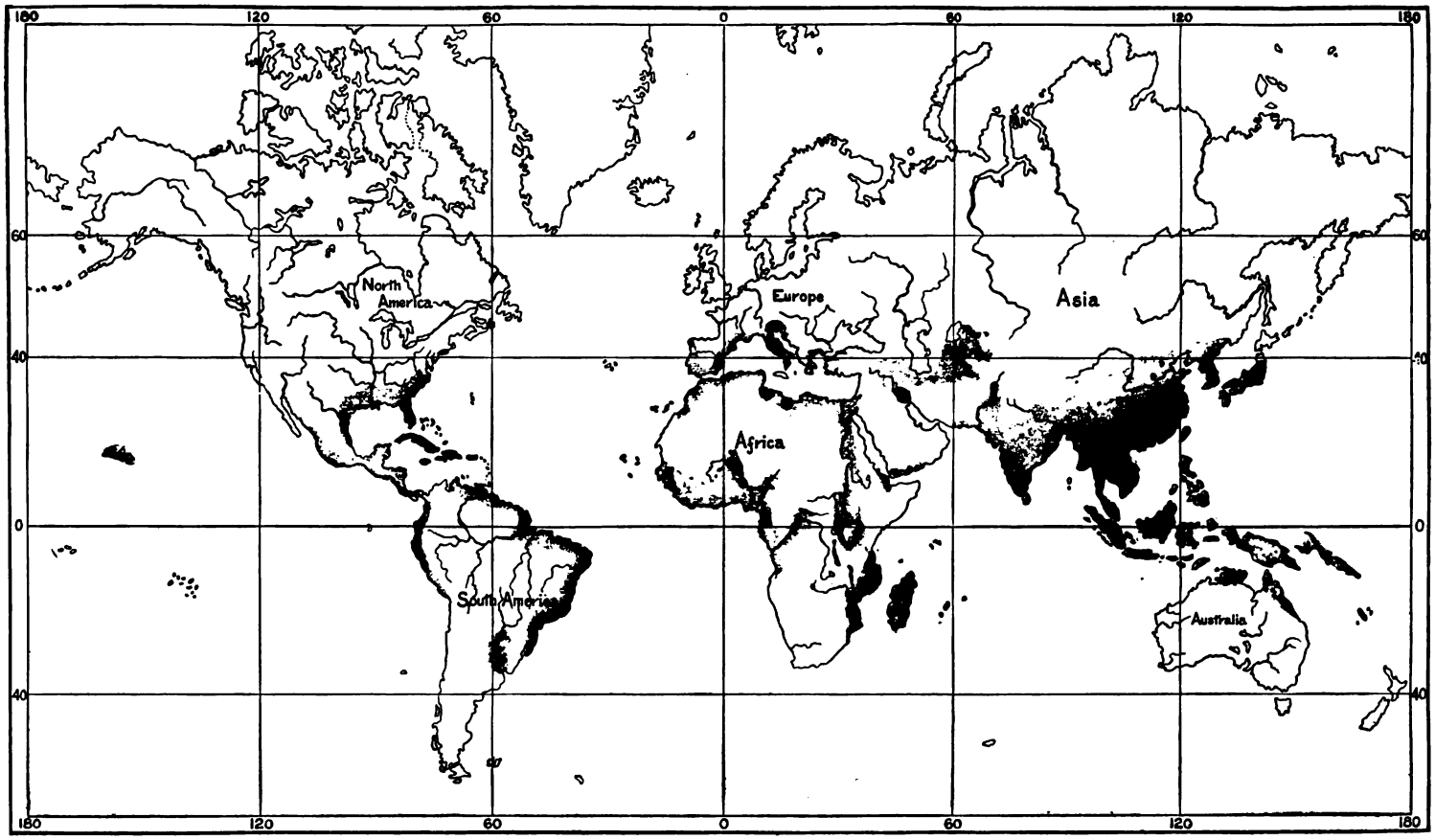
Millet is important as a fodder in nearly all parts of the world, and the grain is used for human food in Japan, China, and India. There are numerous varieties of millet, the commonest of which are European Broomcorn Millet (*Panicum miliaceum*) and Foxtail Millet (*Setaria italica*).

Sorghum is similar to millet. Its seeds are eaten, the juice of its stalks yields sugar (see Sugar), and Broom Corn (*Andropogon sorghum*), one of its varieties, furnishes the stiff tops used for making ordinary brooms.

STARCH

When a plant lays up reserve food for future use it usually stores it in the form of starch. Frequently this is contained in seeds or roots for the use of the young plant in the next generation. In each plant the starch grains have a characteristic shape and size, so that it is possible to identify the different starches by means of the microscope. Starch is an important human food and is mostly eaten with the part of the plant in which it is stored. From many seeds and roots it can be easily extracted. The common starches come from the seeds of corn, wheat, and sometimes from rice or other cereals or from beans; from the roots or tubers of potatoes, cassava (tapioca), arrowroot; or from the pith of the sago palm tree.

The process of separating starch consists of grinding or grating the material which contains it, and washing with water. The starch is not



GEOGRAPHIC DISTRIBUTION OF

RICE

exactly soluble in cold water, but the grains mix readily with it and are easily carried off in suspension, so that the water with the starch can be strained away from the more or less fibrous pulp. The starch settles to the bottom when this milky liquid is allowed to stand for a time, and the clear water is then drawn off and the starch dried. This process varies somewhat according to the material from which the starch is to be extracted; wheat, for instance, is allowed to ferment slightly or is treated with caustic soda to dissolve the gluten, while maize is soaked in water till the grain is softened before being ground up. When starch is extracted commercially on a large scale, the factories are equipped with special machinery.

Corn and potatoes furnish most of the starch used in America and Europe, and the by-products of starch-making are useful as cattle food, for distilling and other purposes (see Maize).

TAPIOCA

Tapioca starch is obtained from the roots of the cassava plant (*Manihot utilissima*). These roots contain in their juice a powerful poison, hydrocyanic or prussic acid, the same substance which occurs in the leaves of the sheep laurel. Fortunately this is easily removed by thorough washing or by heating, so that it does not remain in the prepared starch. Starch is used not only for food and in the laundry, but also finds numerous industrial applications, such as dressing cloth, sizing paper, making paste, etc.

Even more important are the substances made from starch, such as dextrine and grape sugar or glucose.

DEXTRINE

Dextrine, or "British Gum," is made from starch by roasting or by treatment with dilute acids. It is a substance with properties like gum arabic, and is useful in making mucilage, for stiffening cotton textiles, for giving a gloss to paper and cardboard, for thickening colors for calico printing, and for producing a "head" on beer.

GRAPE SUGAR

Grape Sugar is prepared from starch by treatment with hot dilute sulphuric acid. This changes the starch into a substance similar to cane sugar, but not so sweet. It is a very important material, much used in brewing, and as a substitute for true sugar in syrups and cheap candies. Chemically, this sugar is known as dextrose. Commercially, the name glucose is applied to the syrup of grape sugar. The same substance occurs in honey, in grapes, and in many other fruits The white substance often seen on raisins is grape sugar formed naturally.

BEANS

Beans (*Phaseolus vulgaris, etc.*) are a common article of food in nearly all countries. In the American tropics "frijoles" are one of the chief staples, and flour made of beans is used in bread-making. Beans are among the most nutritious foods, being rich in flesh-forming constituents. String beans and marrowfat beans are gathered green, and both pods and seeds are eaten. By cultivation, the common table bean has been made to vary in size, taste, color, and composition. The varieties are known under different names, such as haricot beans, French beans, kidney beans, marrowfat beans, etc., but all are derived from the same ancestral stock. The Lima bean, the soja or soy bean, the pigeon

bean, the green gram, and others are different species. Soy beans are used in eastern Asia for making bean oil. Some beans are used in making starch.

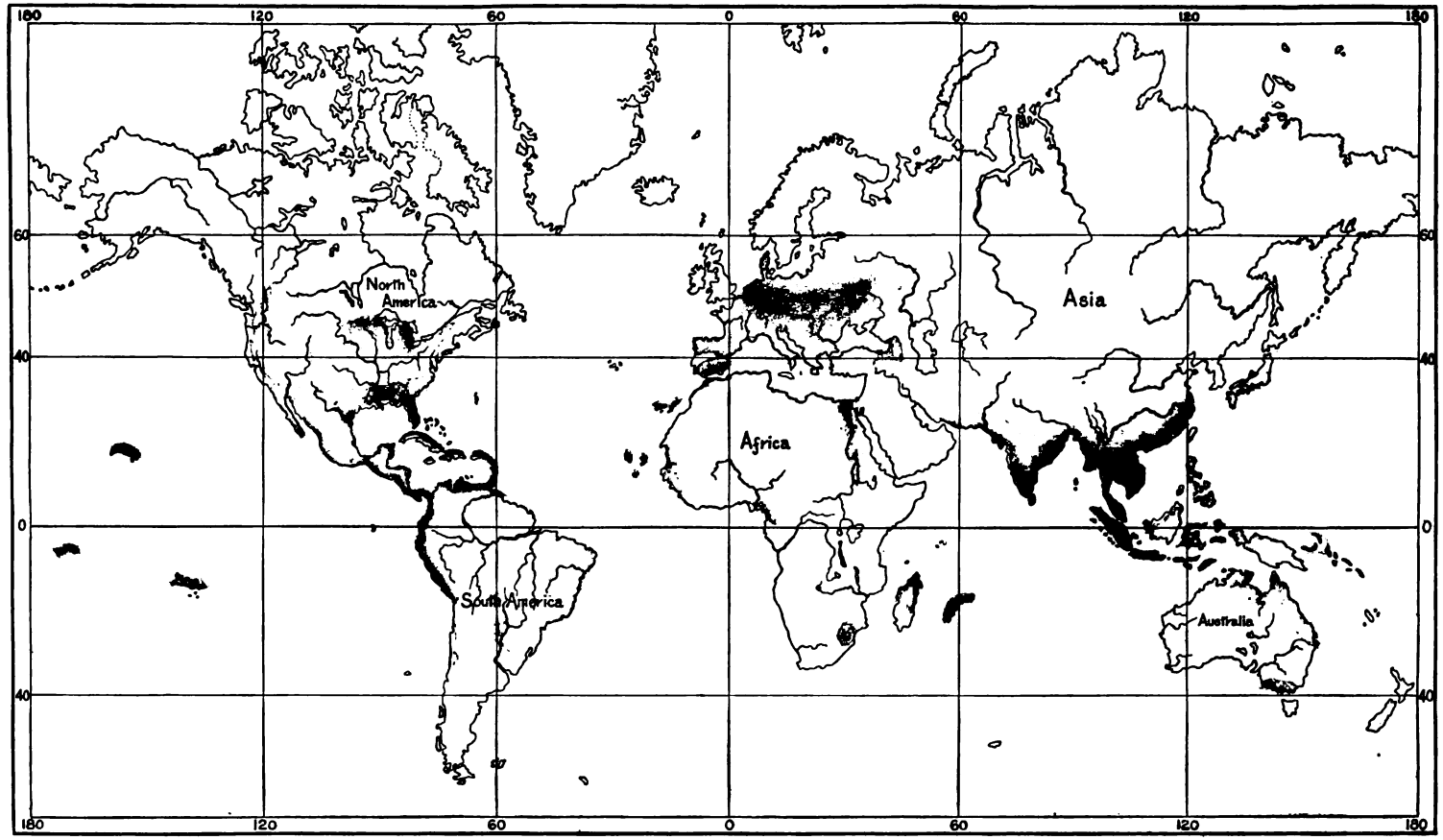
PEAS Peas of several varieties (*Pisum arvense, sativum, etc.*) are important as foods, and are cultivated in nearly all parts of the world. Chick peas, or "garbanzos" (*Cicer arietinum*), are larger than the common pea and are grown in Mexico, Central America and southern Europe. Lentils and vetches are common foods in many parts of the world. They belong, with beans and peas, to the group known as legumes.

SUGAR Sugar is obtained from the juice of the sugar cane (*Saccharum officinarum*) and from the juice of the sugar beet (*Beta vulgaris*). The sugar from these two sources is in every way identical, and is not different in sweetness. Chemically, this substance is known as cane sugar, whether it comes from cane or beet, to distinguish it from grape or other sugars. Two thirds of the sugar used is now derived from beets. Java, Cuba, Hawaii, Brazil, Mauritius, Queensland and Louisiana are the principal places which produce sugar from cane. Germany, Austria, France, Russia, Belgium, and Holland are the important beet-sugar producers.

In extracting sugar from cane, the fresh stalks, which contain as much as 90 per cent. of juice, are crushed between powerful steel rollers. The juice when pressed out is heated and clarified by adding a little lime, and then goes to the evaporating pans where it is boiled, usually in a partial vacuum, to prevent overheating and hasten the concentration. When the liquor has sufficiently evaporated, the sugar crystallizes out and is separated from the molasses in centrifugal machines. The raw sugar resulting from this process is shipped to refineries, most of which are located in the United States and in England, where it is dissolved and purified by treatment with lime, the serum of blood and filters of bone-black. Upon re-crystallization it is perfectly white, and appears on the market as granulated, loaf, or pulverized sugar. Sugar beets are usually rasped and then pressed to extract the juice, or else sliced thin and soaked in warm water. The juice is evaporated and the raw sugar is refined in the same manner as in the corresponding process of treating the juice of cane.

Rum is made in the West Indies by fermentation and distillation of the juice of the sugar cane.

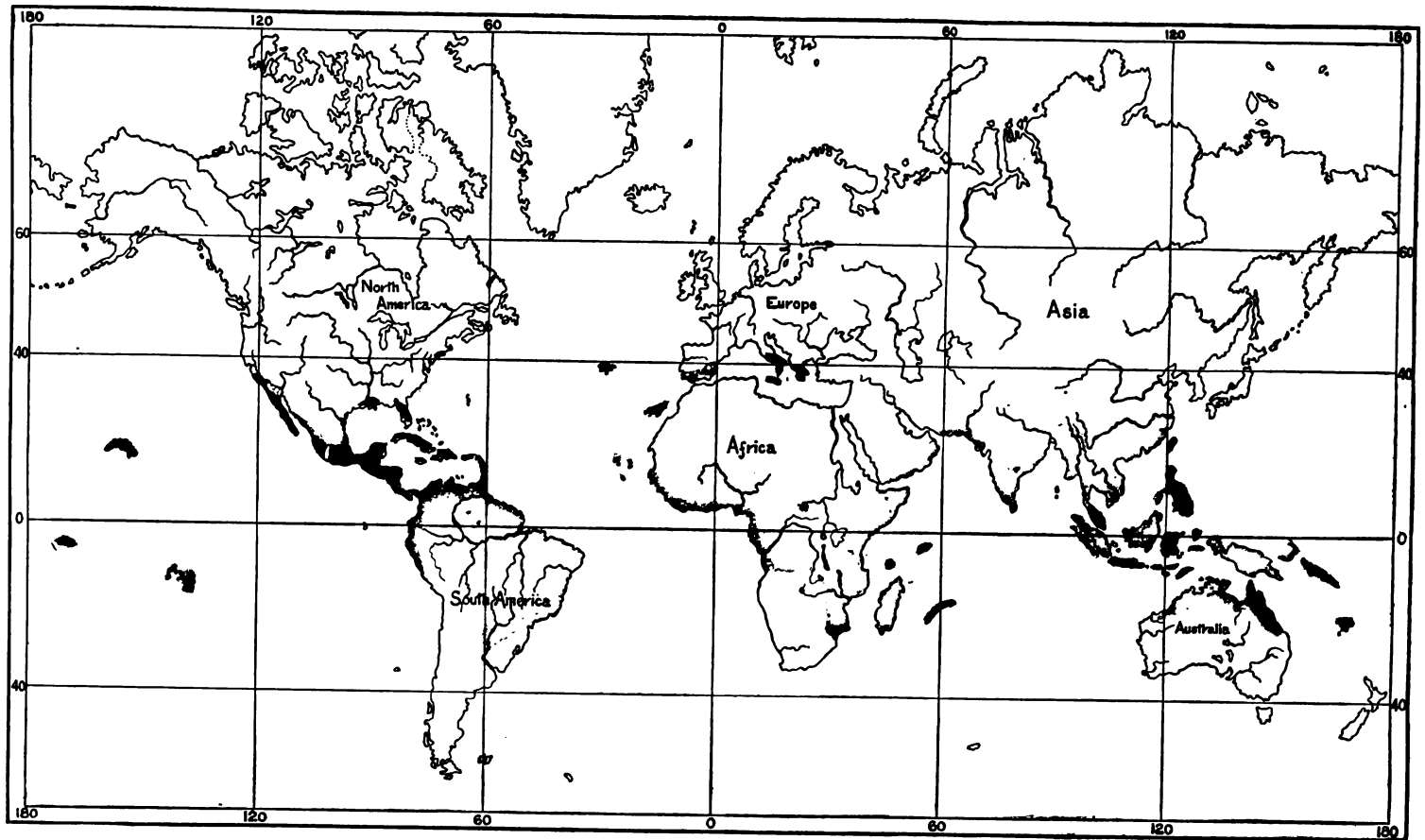
The world consumes more sugar every year, and the percentage of beet sugar in the total product is steadily increasing. This is due partly to the fact that beets are grown in densely populated countries, where the sugar finds a market at once, thus saving the cost of transportation ; partly to the fact that the refuse or pulp from the beets is a valuable food for cattle ; and partly to the assistance given by European governments to the beet-sugar industry in the shape of bounties to producers. Some sugar is obtained from other sources, such as maple sugar in the northeastern United States, and sorghum sugar from the stalks of broom-corn, cultivated in northern India, China, and Japan, and in the central part of the United States. The



GEOGRAPHIC DISTRIBUTION OF

CANE SUGAR

BEET SUGAR



GEOGRAPHIC DISTRIBUTION OF

BANANAS AND PLANTAINS

sugar from sorghum is difficult to crystallize and is, therefore, generally used in the form of syrup.

"Jaggery" is a sugar obtained locally from the juice of certain palm trees. Grape sugar is less sweet than cane sugar and is commonly made from starch (see Grape Sugar). Laevulose or fruit sugar, lactose or milk sugar, and maltose, or the sugar produced in malt, are not of general commercial importance.

VEGETABLES and FRUITS

Vegetables and fruits for table use are important in local trade, especially in the neighborhood of dense populations, but do not play as great a part in the world's commerce as less perishable materials. Large quantities of vegetables are shipped from some European countries and from islands which, like the Canaries and Bermuda, have a favorable climate and a situation convenient to markets. Refrigerator cars make it possible to ship vegetables and fruit from places as distant as California and Florida to the North Atlantic seaboard. Oranges, pineapples, bananas, cocoanuts, and other tropical fruits are important foods where they grow. Large quantities are shipped from the West Indies and Central America to the United States and Europe. Apples, both green and dried, are among the important exports from the United States.

BEVERAGES.

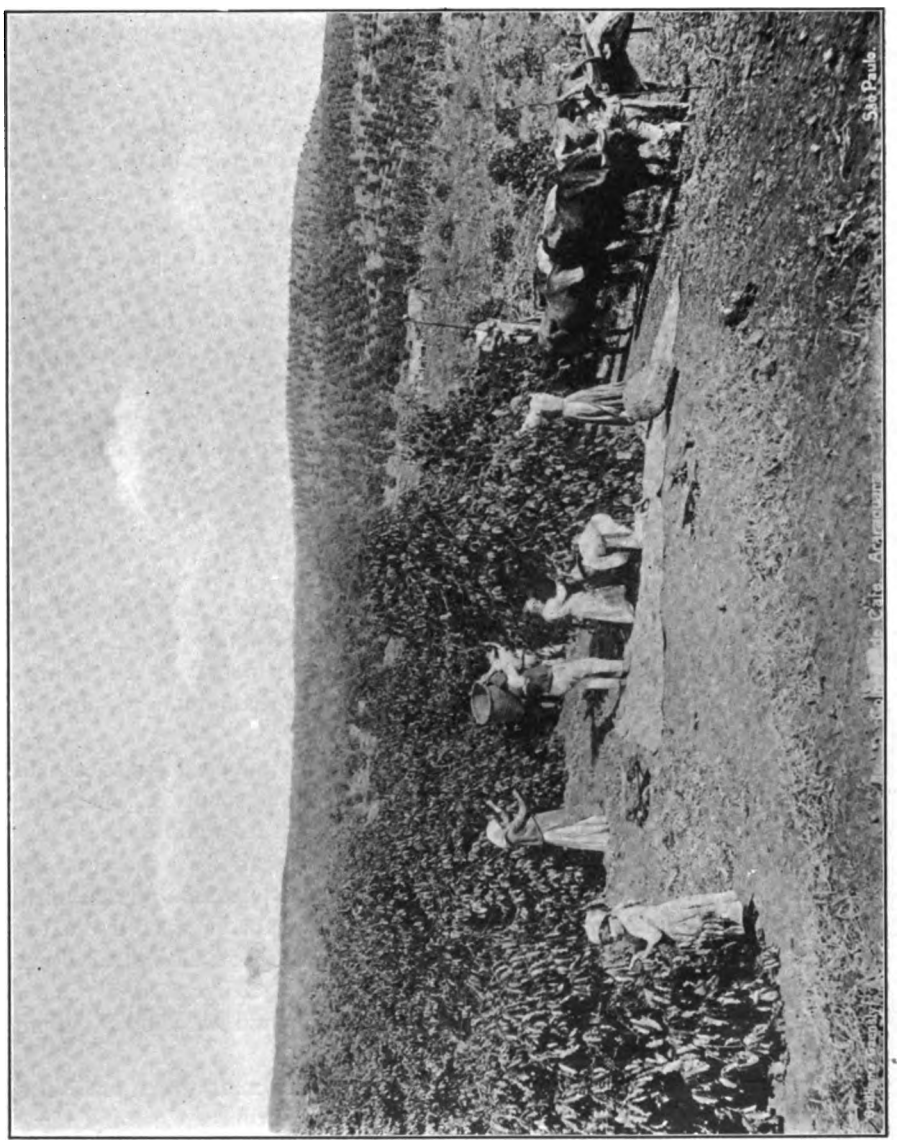
TEA

Tea is produced in China, India, Ceylon, Japan, and Java. It is cultivated in small plantations in South Carolina, Jamaica, Natal, and other localities. Outside of the eastern countries which produce it, tea is consumed principally in the United Kingdom, the British Colonies, Russia, and the United States.

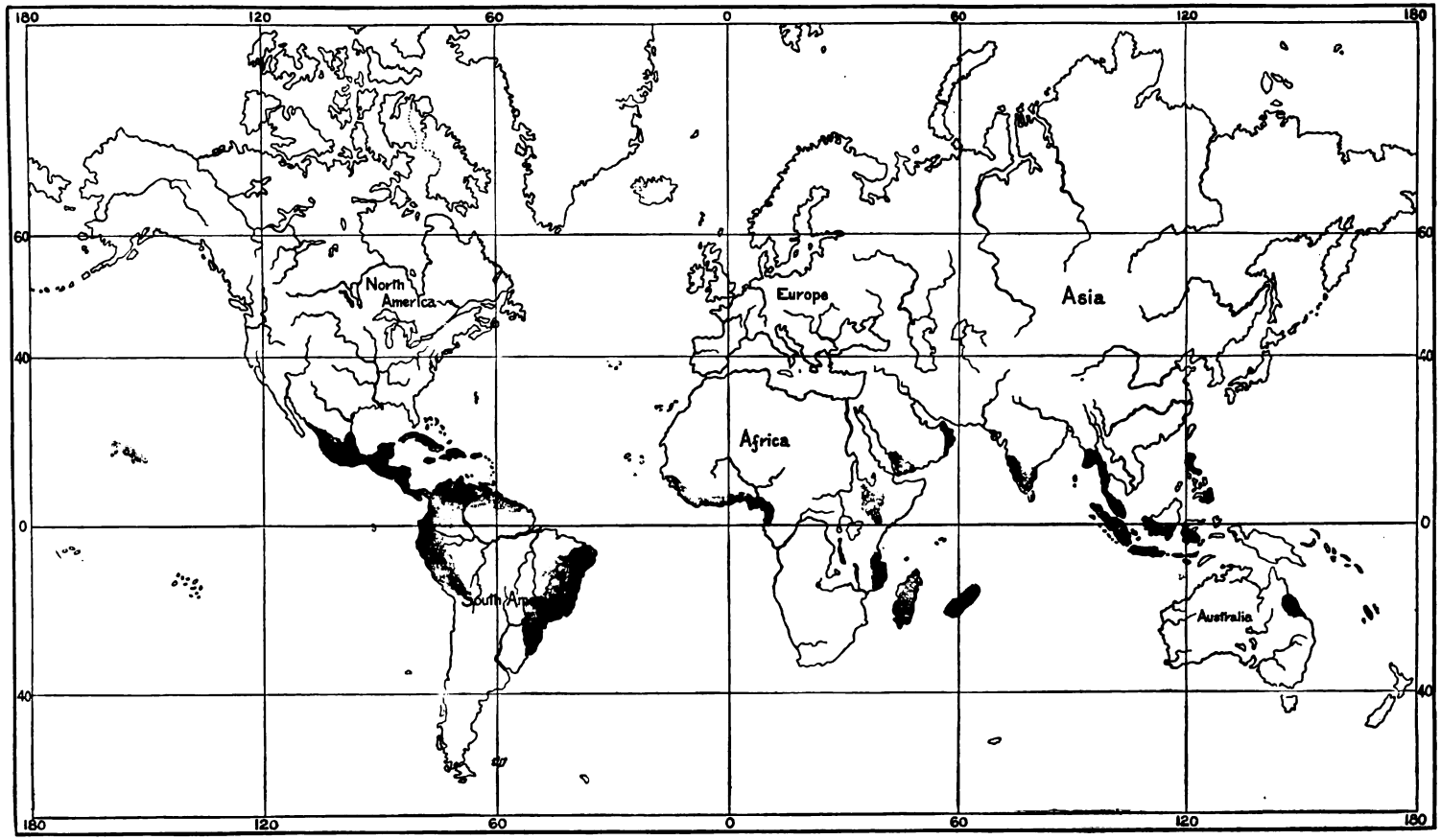
The tea plant (*Thea chinensis*) is usually kept trimmed down to a small bush. Only the young leaves are picked. In some countries where the plant grows rapidly, the pickings are frequent, while in more northern districts the leaves can be picked only once or twice a year. The processes of preparing the leaves differ considerably in various places, and naturally result in teas of different qualities and flavors. In general, after the leaves are picked, if they are to be made into black tea, they are allowed to wither and ferment slightly, and then dried, usually over a charcoal fire. Green teas are prepared by drying the leaves more quickly and not allowing them to ferment, as in the manufacture of black tea.

Teas are classed commercially according to their color, green or black; according to the district producing them, as Japan, Formosa, Ceylon, China, India, Assam, etc; according to the method of preparation, giving "Gunpowder," "Imperial," "Hyson," "Caper," etc., Sun-dried, Pan-fired, Basket-fired, etc; and according to the quality, dependent on the age of the leaf, as "Pekoe," "Oolong," "Souchong," "Congou."

When tea is treated with hot water, the stimulating element (theine or caffeine) which it contains, dissolves readily, together with other constituents



PICKING COFFEE, BRAZIL.



GEOGRAPHIC DISTRIBUTION OF

COFFEE

which give to the drink its taste and aroma. Tea leaves contain also tannin and this dissolves out upon long standing or upon boiling. Tannin is the substance which is contained in many barks and is used to transform skins into leather, and when it dissolves out of the leaves, gives to tea a bitter taste.

YERBA MATÉ

Yerba Maté or Paraguay Tea is used like tea in Paraguay, Uruguay, Argentina and southern Brazil. It consists of the dried leaves of a tree (*Ilex paraguayensis*) of the holly family, which grows wild in that part of the world. It contains caffeine (theine), the same stimulating principle which is found in tea and coffee. In collecting maté, branches are cut from the trees, dried over a fire, and then the leaves and small twigs are pounded to a coarse powder. It is often sewed up in bags made of the skins of freshly-killed cattle, a treatment which the natives think adds to its pleasant flavor. In some large factories it is prepared more carefully, and packed in kegs or cans for shipment. The natives of the lower class, who are the chief consumers, prepare the tea by pouring hot water on the broken leaves, and drink it by sucking through a "bombilla" or metal tube with a sieve at its lower end.

COFFEE

Coffee is grown principally in Brazil. Less than one quarter of the world's product is raised in other countries, chiefly Venezuela, Central America, Java, Mexico, and the West Indies. The United States uses more coffee than any other country.

Coffee is the seed of a shrub or small tree (*Coffea arabica, C. liberica*) which is usually kept trimmed to a height of eight or ten feet for convenience in picking. The berries when ripe are bright red in color and about the size of a cherry. They contain two seeds, each covered by a thin membrane (the "silver skin"), then by a thick, tough skin (the "parchment" or "cascara"), and the whole enclosed in a pulp which holds the two beans with their flat sides together. Some berries, growing on the same plants as the others, contain but one bean, which is round instead of flat, and is called "pearl" or "male-berry" coffee. After picking, the berries are pulped by a machine, washed, and allowed to lie in tanks till the adhering pulp softens. They are then washed clean, and spread on cement or earthen floors in the sun to dry. A cleaning machine next breaks and removes the "parchment," which has become brittle on drying. Further cleaning removes the "silver skin" and polishes the beans, making them ready for market.

The principal commercial varieties are named from the places of production or shipment, as Mocha, Java, Rio, Santos, La Guayra, Guatemala, etc. Mocha and Java coffees may be grown in any country, these names being applied to coffee having a flavor like the kinds which were originally grown in those places. Liberian coffee is produced in many countries by the Liberian coffee tree.

The characteristic flavor of coffee is developed by roasting the beans. The roasting is usually done near the place of consumption, not long before the coffee is to be used.

CHICORY ROOTS Chicory roots, when roasted and ground, are used as a substitute or as an adulterant for coffee. Some persons find coffee harmful, and prefer to use chicory or some other substance, such as roasted barley, to make a drink, since these things do not contain caffeine, the stimulating principle found in coffee, tea, and chocolate. The chicory plant (*Cichorium intybus*) has a pale blue flower, and is a common weed along roadsides. Much of the chicory used is imported from Germany and France, but there are several factories for its preparation in the United States.

CACAO BEANS Cacao beans are the source of cocoa and chocolate. Ecuador exports more cacao beans than any other country. Venezuela, Brazil, Mexico, Trinidad, the East Indies, and Ceylon are important producers.

The fruits of the cacao tree (*Theobroma cacao*) are six to ten inches in length, with thick, leathery rinds, and each contains fifty or more seeds, usually called beans. In some places the seeds, after removal from the pods, are prepared by simply drying in the sun. In other places they are piled up, or buried in earth, and before being dried, undergo several days' fermentation, which, it is believed, develops the flavor and aroma. In commerce both the unfermented and the fermented, or "rotted" beans are extensively used, although fermented beans are considered the best. In the trade, beans are known from their locality of production or shipment, as Esmeralda, Guayaquil, Caracas, Surinam, Mexican, Bahia, etc.

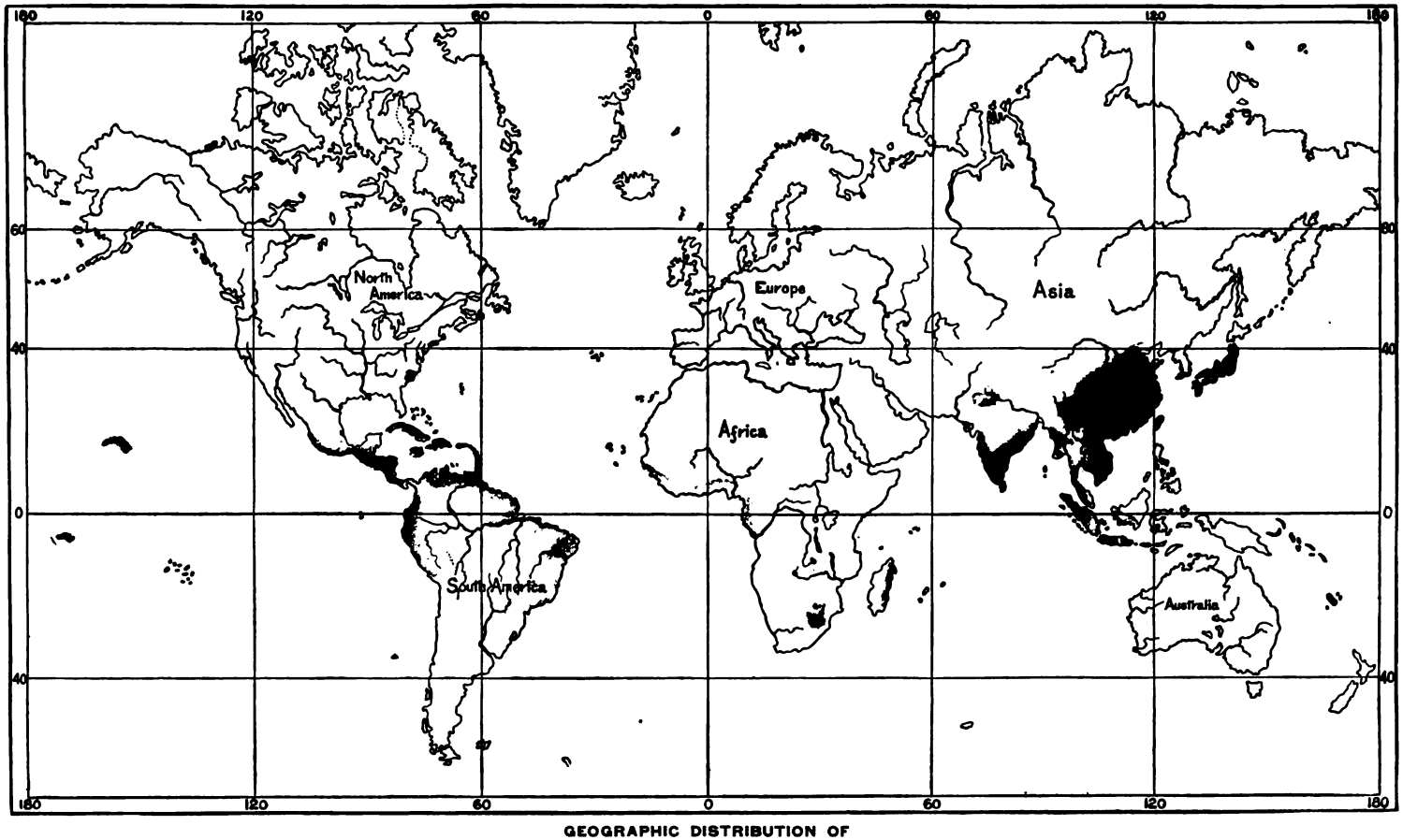
In the process of manufacture, cacao beans are first roasted and then crushed, breaking readily into small pieces. The shells are winnowed out, leaving the fragments of beans known, commercially, as cocoa nibs.

Bitter chocolate is made by grinding cocoa nibs to a fine, smooth paste, which is moulded in cakes; sugar is added to make sweet chocolate, which is often flavored with vanilla. Pure chocolate contains about fifty per cent. of oil.

Cocoa powder is prepared by heating and pressing cocoa nibs in a powerful machine till some of this oil or fat is removed, or by treating chocolate with alkalis, which act on the oil and make easier the mixture of the powder with water or milk in making a drink. The oil, starch, and albuminoids contained in chocolate and cocoa render them very nutritious, and a small amount of theobromine (which is similar to caffeine) gives them a mildly stimulating effect.

Cocoa butter, the solid oil extracted in the manufacture of cocoa powder, is very important for the manufacture of medicinal salves, since it does not easily become rancid. The thin shells broken off the outside of cacao beans are used to some extent in making a beverage.

ALCOHOLIC LIQUORS Alcoholic liquors are very important from a commercial and industrial standpoint. Wines of many grades are made, mostly from grapes, by fermentation of the juice. France, Italy and Spain are the great wine countries. California and New York produce most of the wine made in the



GEOGRAPHIC DISTRIBUTION OF

TEA

CACAO

United States. In fermentation, sugar is changed into alcohol. The sugar may be the natural sugar of fruit or cane, or may be glucose prepared from starch (see Barley, Malt, and Grape Sugar).

Fermented liquors yield strong alcoholics by distillation. Brandy is distilled from wine, and rum from the fermented juice of sugar cane. Whiskey is distilled from fermented grain, generally either corn or rye. By careful re-distillation pure alcohol is obtained.

All parts of the world use more or less alcoholic liquors. The favorite beverage in Japan is saké, a wine made of rice ; in Mexico it is pulqué, the fermented juice of the century plant ; in parts of India and some of the Pacific Islands it is "toddy" or "tuba," from the sap of the cocoanut palm ; and many other countries have their peculiar drinks. In nearly all civilized countries taxation of the manufacture and trade in alcoholic liquors is one of the important sources of public revenue.

HOPS

Hops are used chiefly in brewing. They are the dried fruits of the hop vine (*Humulus lupulus*) and are raised in the United States in California, Oregon, Washington, New York and Wisconsin. They are cultivated in most countries of Europe, but especially England, Germany, and Austria. Hops are added to the malt liquor or "wort" (see Barley), which is then boiled, and afterward fermented by adding brewer's yeast. After two or three days' fermentation the beer is freed from the yeast, placed in settling tanks, and clarified before being placed in kegs or bottles. Hops give a bitter flavor to malt liquors.

SPICES.

MUSTARD

Mustard is the most common and commercially, the most important spice. Several plants belonging botanically to the genera, *Brassica* and *Sinapis*, produce mustard seed. They grow in most parts of Europe and the United States, as well as in Asia and the East Indies. The seeds vary in color, being black, brown, red, yellow, and white. Black and yellow mustard are the most important kinds. When the seeds are pressed they yield an oil, which in India is used for burning and in soap-making. Black mustard, when powdered, produces on mixing with water a very pungent essential oil. This oil is not formed by white or yellow mustard, but is produced in larger quantities by a mixture of the black and yellow. To this oil is due the pungent smell and taste of ground and prepared mustard and its inflammatory action on the skin.

PEPPER

Pepper, one of the common spices, comes mostly from Singapore. The two kinds, black and white pepper, are produced by the same vine (*Piper nigrum*). The berries are gathered when they begin to turn red, picked, cleaned, and dried for several days on mats in the sun, or in bamboo baskets before a gentle fire. This mode of preparation gives black pepper, as in drying, the pulp shrivels and turns black. For white pepper the berries are allowed to ripen on the vines, and are then bruised and washed free from the pulp before drying. Long

peppers, the young fruits of a similar vine (*Piper longum*) when ground are sold as black pepper. Pepper is one of the spices earliest used by mankind, and although now a commodity of but small importance in comparison with sugar, cotton, or coffee, it was for a long time the staple article of trade between India and Europe, having a very important place in that commerce at the time of the discovery of America.

Red pepper or Cayenne pepper is the fruit of a plant (*Capsicum* species) of a different genus. It is grown throughout the civilized world, being used in large quantities in Mexico, Central and South America.

ALLSPICE

Allspice or "Pimento" is the dried unripe fruit of a tree (*Pimenta officinalis*) which is cultivated chiefly in Jamaica. It is gathered by breaking off twigs bearing bunches of the berries, and drying them in the sun. Its extensive use as a flavoring is due to its cheapness. The name pimenta is commonly applied to peppers and other spices.

CARAWAY SEEDS

Caraway seeds are used in flavoring bread, cakes, and liquors. The small herb (*Carum carvi*) which produces them is grown in northern and central Europe and Asia as well as in the United States.

CLOVES

Cloves are the dried, unopened flower buds of a tree (*Jambosa caryophyllus*) which originally grew in the Molucca Islands. Zanzibar and the neighboring island of Pemba are the source of most of the commercial supply, although cloves come also from Amboina and near-by islands of the Molucca group, from Sumatra, Reunion, Mauritius, and other islands of the East and West Indies. In Zanzibar, each clove is picked separately, a moveable stage being used to enable the pickers to reach the upper branches. In other places the buds are often beaten off the trees on to cloths spread beneath. Cloves are used as a spice for food, confectionery, and liquors. Clove oil, obtained by distillation with water, is used for the same purposes, and in medicine and dentistry.

NUTMEGS

Nutmegs are the kernels of the fruit of a small tree (*Myristica fragrans*) which is cultivated in the Banda Islands and other parts of the East Indies, in Zanzibar, Reunion, the West Indies and South America. The kernels grow covered with a thin shell, which is in turn enveloped in a bright red, lace-like seed coat, within the pulp of a fruit which looks like a small pear. The red seed-coat when dried is the mace of commerce. Nutmegs are usually coated with lime to give them a white appearance.

VANILLA

Vanilla is produced in greatest amount and of best quality in the State of Vera Cruz, Mexico. It is grown also on the islands of Reunion, Mauritius, and Tahiti, and in small quantities in a few other places. It is the prepared unripe fruit of a kind of orchid (*Vanilla planifolia*). The Mexican "beans" are slowly dried, the process taking several weeks; they are allowed to ferment slightly, and during the time of curing, the flavor is developed. Much the same result is arrived at in a more rapid manner by the use of hot water or calcium

chloride in other processes used in Bourbon and Tahiti, but such beans do not bring so high a price. Vanilla and vanilla extracts are used for flavoring chocolate, ice-cream, cakes, candies, etc. The poorer grades are used extensively to flavor chewing tobacco.

Tonka beans have been used to adulterate vanilla, and in making vanilla extracts. They are on the market now only in small quantity, being displaced by cheap grades of true vanilla. Vanillon is an artificial vanilla extract. It has been made of coal tar, but is now manufactured in large quantities in the United States from oil of cloves.

GINGER

Ginger consists of the dried root-stalks of the ginger plant (*Zingiber officinale*). It is grown in most tropical countries, particularly in Bengal, Cochin China, China, Africa, and Jamaica. It is found in commerce in two classes—"coated," and "uncoated" or "peeled." Coated ginger is produced by drying the green roots in the sun. Uncoated ginger has been washed and peeled, or scraped, before being dried, and is usually bleached and covered with lime. Ginger is used as a flavoring and stimulant in foods and in drinks like ginger ale, and is often preserved in syrup, or candied for use as a sweetmeat.

TURMERIC

Turmeric consists of the underground stems of a plant of the ginger family (*Curcuma longa*). It is grown in southeastern Asia and the neighboring islands. It is an important condiment used in curry powder. In solution it gives a beautiful yellow dye for cotton goods. Tanners use turmeric in preparing fancy leathers, and chemists use paper colored with it in testing for alkalis and for boric acid.

CINNAMON

Cinnamon is the dried bark from the young twigs of a tree (*Cinnamomum zeylanicum*) which grows in Ceylon. Chinese cinnamon or cassia bark comes from similar trees which grow in China, northern India, and other places. It is inferior to the true cinnamon, but is much more common.

There are other less important spices, such as cardamom, coriander, anise, and pistachio, besides many things such as sarsaparilla, fruit juices, and extracts, aloes, and essential oils used for flavoring. Many flavoring materials, extracts, etc., are made artifically in the chemical laboratory.

OILS.

VEGETABLE OILS

Vegetable oils of many kinds are used for food and for cooking. In this country, olive oil is the most popular. True olive oil is produced in Mediterranean countries and in California. It is often adulterated with oil from cotton seeds. (See Cotton.) In other parts of the world, oils obtained by pressing other seeds, such as peanuts and sesame, are extensively used. (See Oils and Oilseeds.)

MEDICINES AND STIMULANTS.

Medicines are obtained from the flowers, seeds, leaves, gums, twigs, bark, or roots of many plants and trees. The crude substances which yield medicines are called drugs. The bark or other part of the plant is usually ground up and soaked in water to dissolve out the medicinal principle. Quinine, sarsaparilla, licorice, coca, nux, opium, aconite, arnica, belladonna, ipecac, rhubarb and others are familiar examples. They are obtained in various parts of the world, and their production in some places is very important, as in Java, where most of the quinine bark comes from. Some seeds, like castor beans, yield oil with medicinal properties. Some substances of animal origin and many of mineral origin, such as salts of arsenic, iron, and mercury, and other compounds made from coal tar, such as antipyrine, are of great medicinal value. Medicinal substances and prepared medicines are an important item in both the imports and exports of the United States.

MEDICINES

Tobacco is the most extensively used narcotic. It was originally a native of America, and has spread over the entire world since the year 1600. It is now used commonly not only by civilized peoples but also by savage tribes in the interior of Africa, and by Chinese and other peoples, in districts where modern civilization and commerce have not penetrated. The many gradations in the quality and flavor of tobacco are due to differences in soil, climate, and cultivation.

TOBACCO

When the plant (*Nicotiana tabacum*) is mature it is cut and hung up in open buildings to dry. The "curing" of the leaf, which includes a period of slight fermentation, gives to it its characteristic odor. The flavor of nearly all cut tobacco and chewing tobacco is altered by the use of molasses, licorice, vanilla, or other substances. Only the best leaves can be used for making cigars. The stems or midribs of the leaves are used for low grades of smoking tobacco and snuff, for making sheep-dip, and for fumigating greenhouses.

The varieties are known commercially from their localities of export or production, as Havana, Sumatra, Mexican, Turkish, Virginia, etc. Much Havana tobacco (meaning tobacco of the same variety, from the seeds of Cuban plants) is raised in Connecticut and elsewhere in the United States. More tobacco is raised in the United States than in any other country, and over half of the product is exported, mostly to England. In Europe it is cultivated principally in Austria-Hungary, Russia, Germany, Netherlands, Belgium, and Turkey. Cuba, Porto Rico, Mexico, Central and South America, India, China, Java, Sumatra, the Philippines, Ceylon, and Cape Colony are important producers. Large revenues are raised in many countries from the taxation of tobacco.

Opium, in addition to its medicinal value, as the source of laudanum and morphine, is extensively used as a narcotic in China and the East. It is the dried juice of the white poppy (*Papaver somniferum*) obtained by scratching the seed capsule. The juice

OPIUM

exudes in small drops and is collected. Its production is an important industry in northern India, China, Persia, and Asiatic Turkey. The Chinese, who consume more than any other people, smoke opium in small pipes, and it is taken in pills in Persia and Turkey. The government of India secures a revenue of over $10,000,000 yearly from the opium trade. The United States imports opium for medicinal purposes from Turkey.

ARECA NUTS Areca nuts, sometimes called betel nuts, are chewed by the people of India and by the Malays and Chinese throughout southeastern Asia and the East Indies. The nuts, the seeds of the areca palm tree (*Areca catechu*) are boiled, sliced, a little lime is added, and the mixture is chewed with a leaf of betel pepper. Areca nuts are also used in medicine.

COCA LEAVES Coca leaves, the source of cocaine, are mixed with lime and chewed by the natives in Bolivia and neighboring countries. They come from the coca tree (*Erythroxylon coca*).

KOLA NUTS Kola nuts (*Cola acuminata*) are grown in Africa and the West Indies. The Africans chew them for their stimulating effect. Kola wine and syrup are valued for their medicinal qualities.

VEGETABLE FIBERS.

From leaves and leaf-stalks—(Manila hemp, agave fibers, New Zealand flax, raphia, palmetto, etc.); from the bast of plants—(flax, hemp, jute, ramie, linden bast, etc.); from fruits—(cocoanut, luffa); from plant hairs—(cotton, silk cotton); artificially prepared fiber—(paper, artificial silk); from whole stems or parts of plants—(straws, broom corn, Spanish moss, rattan, etc.).

(For animal fibers see Silk, Wool, etc., and for mineral fibers see Asbestos.)

Many fibers, especially those used for ropes and brushes, are oiled to make them flexible and to keep them from becoming dry and brittle.

MANILA HEMP Manila hemp is the strongest rope fiber in common use. It is obtained in the Philippines from the leaf-stalks which form the apparent trunk of a tree (*Musa textilis*) of the banana family. This tree is like the common banana tree except that the leaves are a little narrower and it does not produce edible fruit. To obtain the fiber the tree is cut down, the leaves removed and the leaf-stalks separated, and scraped with a dull knife till all of the pulpy part is cleaned off. The coarse fibers which remain are then washed, dried, and made up into bales. They are longer than any other commercial fibers, and the rope and twine made from them do not harden nor stiffen when wet. The natives of the Philippines use the finest fibers in making "abaca" cloth.

SISAL HEMP

Sisal hemp or henequen comes chiefly from Yucatan, where it is the principal article of export. It is cultivated in other parts of Mexico, in Central America, the West Indies, and, to a small extent, elsewhere. It is obtained from the fleshy leaves of a plant (*Agave rigida*, var. *sisalana*), which in Pennsylvania would be called a "Century Plant." The fiber is obtained by cutting the leaves and scraping the fleshy part away with a large wooden knife, or otherwise cleaning it by machinery. These fibers are stiffer and less strong and not so long as those of Manila hemp, but are much used for making rope and twine, in the manufacture of sacking for cotton, and in making brushes.

THE AGAVE PLANT

The Agave plant or Maguey, in this country popularly called the "Century Plant," is a native of Mexico, where there are many species. It is, perhaps, the most useful plant which grows in that country. Sisal hemp (see above) is one of its products. There are other important fibers produced by agave plants, such as Tampico hemp, sea grass, maguey, ixtle, lechuguilla, pita, and yaxci. Some of these are exported and all of them are used locally to make articles of all kinds, such as mats, bags, ropes, harness, hammocks, hats, baskets, brushes, etc. In their native home, agave plants reach maturity and flower at an age of three to fifteen years according to their species. The flower stalk, coming out of the centre of the plant, often reaches a height of thirty feet.

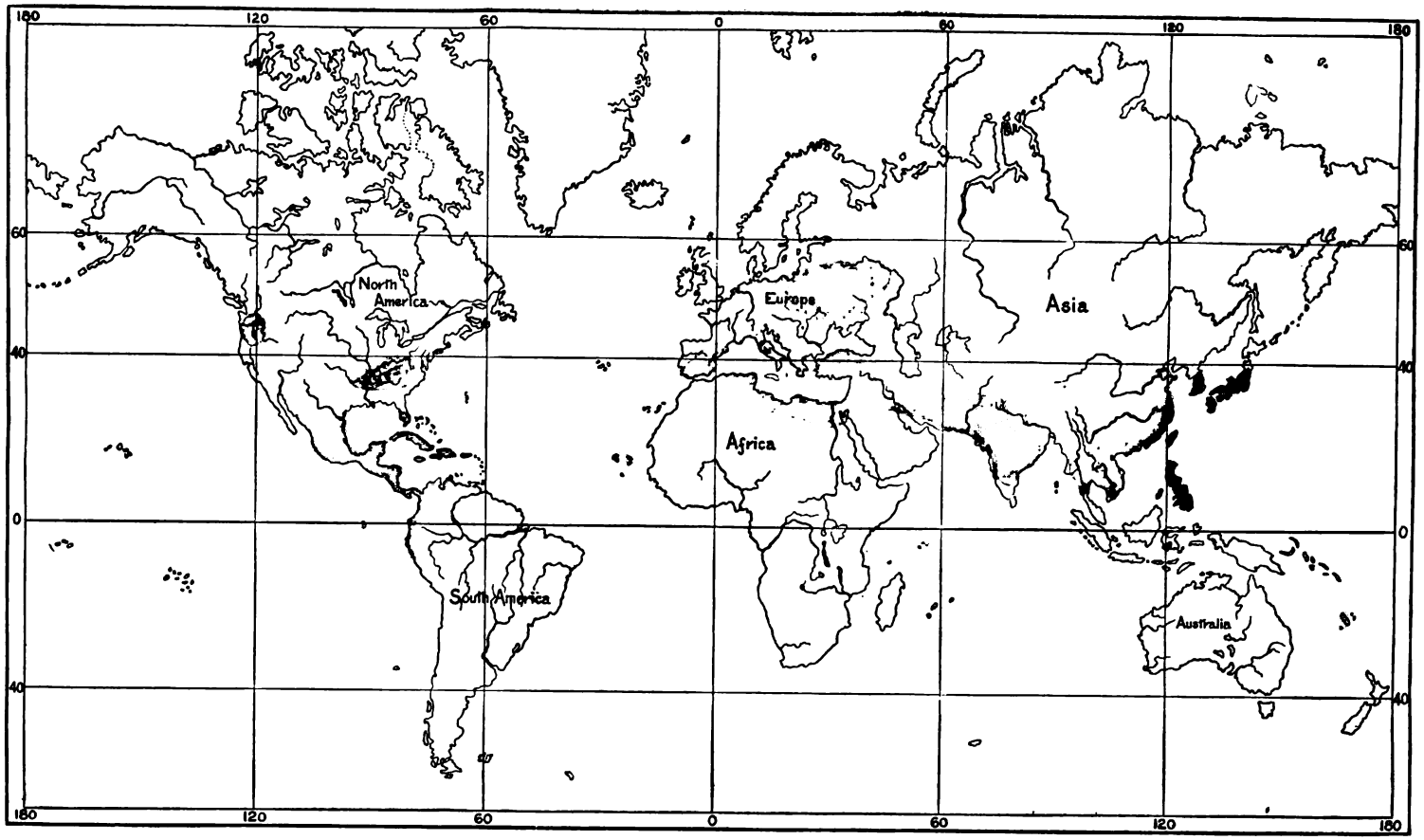
There is one variety of agave plant which is cultivated in Mexico for its sap, from which a drink, "pulqué," is made. When the plant is ready to bloom, the central bud is cut out, leaving a cavity holding a couple of gallons. Into this the sweet sap exudes, and is removed twice a day, being sucked into a long narrow gourd and emptied into a goat-skin bag. It is then mixed with milk and a little rennet, in a vat of raw oxhide, where it ferments rapidly and forms an intoxicating drink. "Mezcal," a stronger alcoholic drink, is distilled from the fermented juice of another kind of maguey plant. Agave plants furnish many articles of minor use to the natives of Mexico, such as building material and razor strops from the flower stalks, soap substitute from the roots, and natural needle and thread from the leaves.

NEW ZEALAND FLAX

New Zealand flax, another excellent rope fiber, comes chiefly from New Zealand. It is obtained by scraping away the pulpy part from the long narrow leaves of a plant of the lily family (*Phormium tenax*). Other similar fibers are Mauritius hemp (*Furcraea gigantea*), bowstring hemp (*Sansevieria*), pandanus, yucca, and aloe.

PINEAPPLE FIBER

Pineapple fibers are obtained by scraping away the fleshy parts from the leaves of plants of the common pineapple (*Ananas sativa*) or closly related plants. These fibers are finer and shorter than those from agave plants and are much used by the Filipinos for making a fine cloth called "piña." In China, Mexico, South America, and in parts of Africa, pineapple fibers are much



GEOGRAPHIC DISTRIBUTION OF

SISAL HEMP AND OTHER AGAVE FIBERS

HEMP

MANILA HEMP

used for making cloths, ropes, etc. Throughout Mexico, Central and South America, fibers from plants nearly related to the pineapple (*Bromelia* species) are used. These fibers are not of very great importance in the world's commerce.

RAPHIA Raphia fiber from Madagascar is used principally by gardeners for tying plants. It consists of strips of skin peeled by hand from the surface of the leaflets of a palm tree (*Raphia pedunculata*). It is used for making mats and basketry, and by the natives for weaving cloth. A similar raphia palm yields a fiber used locally in West Africa.

PIASSABA Piassaba or bass is a coarse stiff fiber used for making brooms and brushes. It comes in lengths up to four feet and in diameter from one thirtieth to one sixteenth of an inch. The commercial varieties are known as West African and Brazilian (Bahia and Pará) bass. They are obtained from the fibrous sheaths which grow around the leaf stalks of certain palm trees. The West African bass comes from the tree (*Raphia vinifera*) which yields the leaf fiber referred to above. The sap of this tree is used by the natives in making wine. The Bahia piassaba (or piassava) comes from a different palm (*Attalea funifera*), and the Pará bass from another (*Leopoldinia piassaba*).

Somewhat finer brush fibers are obtained from the leaf sheaths of other palm trees, such as kittool (*Caryota urens*), Palmyra fiber or bassine (*Borassus flabellifer*), Chinese coir, etc. These last-mentioned fibers come chiefly from Ceylon, India, and China.

SAW PALMETTO Saw palmetto is used for making brushes, and for mixing in plaster, as well as for paper stock. It is obtained in our southern states from the leaf stalks and the creeping stems, commonly called the roots, of the saw palmetto palm (*Serenoa serrulata*). This plant is rich in tannin and is an important source of tanning extracts. The fiber is the spent material from which the tannin has been extracted. This palmetto grows wild in the Gulf States and its leaves are utilized in making the artificial palms commonly used for decorations.

BAST FIBERS Bast fibers occur in many plants, in a layer underneath the outer bark. In small plants like flax, they are fine in texture and serve to strengthen the stalk, while in trees like the linden they are coarse.

FLAX Flax ranks next to cotton as a useful fiber. It is the bast fiber of an herb (*Linum usitatissimum*) which grows to a height of about two and a half to three feet. Russia produces more than one half of the world's supply of flax, but that from Belgium is the best quality. Italy, France, Holland, Ireland, and Egypt are the other important producers. A little flax fiber is grown in Michigan, Minnesota, and the Puget Sound region. Flax plants are not cut, but pulled from the ground, so as to get the longest possible fibers. The seeds are then removed by "rippling" or drawing through the teeth of an iron comb, and the stalks

"retted." "Retting" is merely a process of slow and partial decay, which is carried on by soaking the stalks in water, either in a pool or slowly running stream, or by laying them on damp meadows exposed to the rain and dew. The fiber remains unaffected while the other parts of the plant are softened by this treatment. The stalks after "retting" are "broken" by pounding and then "scutched" or scraped with a broad wooden knife till all of the woody portion is removed. It is then "hackled," or combed, to separate the long fibers, or "line," from the short fibers, or "tow," and the long fibers are prepared for spinning. Most of this work is done by hand in preparing the best grades of flax. Twines, canvas, linens, and laces are made of flax. It is bleached by exposure to the sun, and by treatment with a dilute solution of chloride of lime. Flax, especially in the form of linen rags, is used in paper-making.

Flax plants which grow till the seeds are fully ripe yield fiber of poor quality, but the seeds are then richer in oil; the growing of flax for seeds is, therefore, a separate industry. The seeds are grown extensively in Russia, India, Argentina, and the United States.

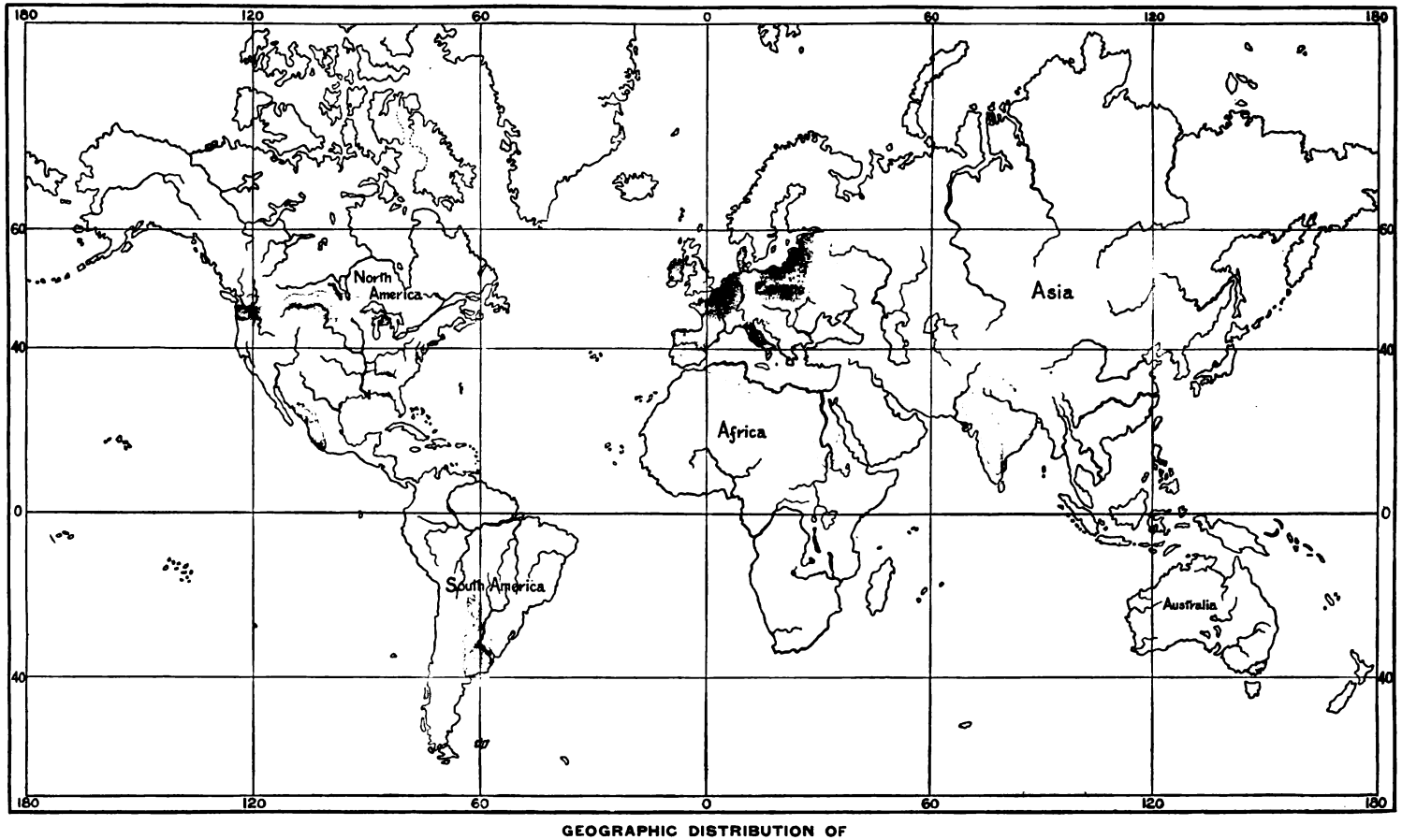
LINSEED OIL

Linseed oil is made by crushing flax seeds and then pressing them in a machine. When the seeds are heated and pressed, more oil is obtained; but "cold drawn" oil is of better quality. Linseed oil-cake remains after the oil is extracted from the seeds, and is a valuable cattle food. On drying, linseed oil forms a varnish-like substance. This property makes it useful in paints and varnishes. Boiled linseed oil is prepared by heating the raw oil and adding to it certain substances which cause it to dry more rapidly. After much boiling it becomes thick and is the basis for printer's ink. Linoleum is made of linseed oil mixed with ground cork and gums. The oil is sometimes vulcanized by heating with sulphur, giving a substance much like rubber.

Flax seeds are used in making poultices.

HEMP

Hemp is a fiber used extensively for making twine and rope. True hemp is the bast fiber of a plant (*Cannabis sativa*) which grows to a height of six to ten feet, with stems as thick as a man's finger. Russia produces more hemp fiber than all the rest of the world, but the plant is cultivated throughout the warm parts of Asia, in Italy, France, Hungary, Germany, and Algeria, and in Kentucky, Missouri, Illinois, and California. The fiber is extracted by retting, cleaning, and combing in much the same way as flax, except that more of the work is done by machinery. As in flax, the long combed fiber is called the "line," and the short strands "tow." The commercial fiber is much longer and coarser than flax, but not so strong, and cannot be bleached perfectly white; it is therefore unsuitable for weaving into fine fabrics. Hemp is known on the market from its country of origin, as Russian hemp, the strongest; Italian hemp, the finest; Kentucky hemp, etc. Many other fibers coming from plants which are botanically different, are called by such names as Sisal hemp, Tampico hemp, Manila hemp, Mauritius hemp, sunn hemp, bowstring hemp, etc.



GEOGRAPHIC DISTRIBUTION OF

FLAX FIBER

JUTE FIBER

Hemp seeds are pressed like flax seeds and yield hemp oil, which is similar in nature to linseed oil and is used in soap-making and in paint. An extract from the leaves is used as an intoxicant (hasheesh) in Arabia.

JUTE

Jute comes almost entirely from the province of Bengal, India. It is the bast fiber of plants (*Corchorus* species) which grow in tall slender stalks like hemp. It is separated from the stalk like hemp, by retting and cleaning. The fiber is long and lustrous, soft, and easy to spin into coarse threads. It is much weaker than hemp, difficult to spin into fine threads, does not bleach well, and loses in strength when exposed to dampness. It is used for making burlap and gunny cloths, twines and ropes, as well as in carpets, curtains, and upholstery fabrics, such as plushes.

JUTE BUTTS

Jute butts are the short ends of the stalks and the rough fibers rejected in preparing jute. They are very important paper stock, being imported in large amount.

RAMIE

Ramie or China grass is a fiber of increasing importance. It grows in southeastern Asia and is cultivated in small amounts in Mediterranean countries and other parts of the world. The plant (*Boehmeria nivea*) belongs to the nettle family and grows in tall slender stalks like hemp. The bast fiber is difficult to separate from the bark, owing to the presence of a gummy substance insoluble in water. It has been used for a long time in China, where it is prepared in a slow and imperfect way. Improvements in machinery and in the chemical process of cleaning the fiber are making it possible to utilize it in Europe and America. The clean fiber is fine and silky; its strength is three times that of Russian hemp, and its weight only a little over half that of linen. It is a very valuable cordage fiber, and is extensively used in China for making "grass cloth." In Europe it is made into fabrics, some of which closely resemble silk, into underwear, velvets, and various cloths. It will come into more general use when cheaper methods of cleaning it are devised.

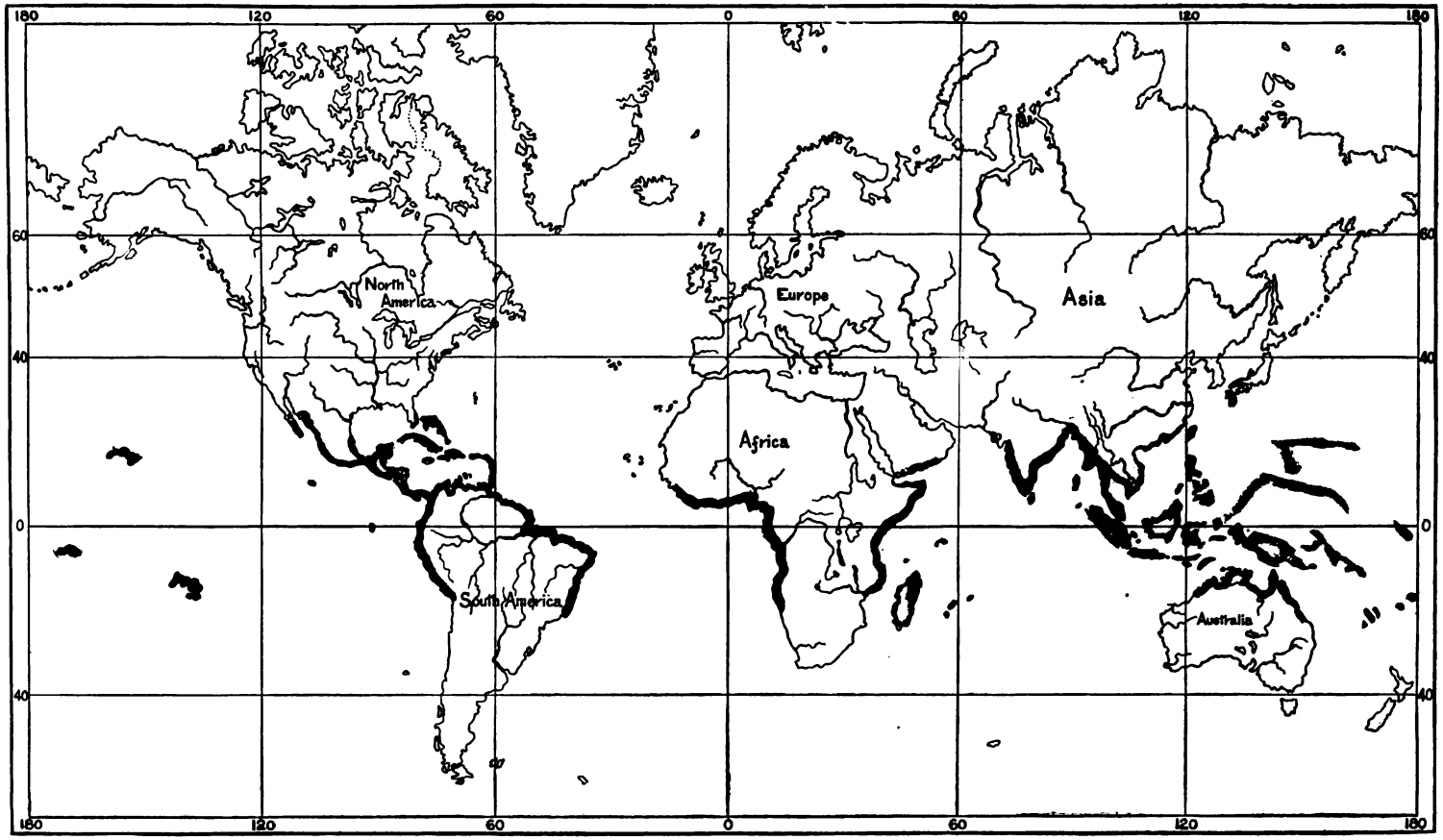
BAST FIBER

Bast fibers from other plants are extracted and used in various parts of the world; but few of these are of any general importance. Sunn hemp (*Crotalaria juncea*) is grown in India. The common European linden or lime tree has a bast which is easily stripped off and is employed by peasants for making ropes, mats, bags, hats, etc. The American linden or bass wood tree contains a fiber of the same kind. A beautiful material called Cuba bast is obtained in sheets from a tree (*Hibiscus elatus*) in the West Indies. It is used like braid in making hats and for tying bundles of cigars. Lace bark is the bast of another West Indian tree (*Lagetta lintearia*). The paper mulberry tree (*Broussonettia papyrifera*) furnishes a bast used in paper making and, by natives in Oceania, for making bark cloth ("tapa").

THE COCOANUT PALM

The cocoanut palm is, in the countries where it grows, one of the most useful plants, in fact in many islands it is looked upon as the one thing necessary to existence. Cocoanut palms (*Cocos nucifera*) grow in the coast regions of all tropical countries, frequently reaching a height of a

COCOANUT TREES JAMAICA



GEOGRAPHIC DISTRIBUTION OF

COCOANUT TREES

hundred feet, with a crown of twenty or more feathery leaves, each twelve or fifteen feet long. The fruits, cocoanuts, are produced from the time the tree is five or six years old, sometimes for sixty or more years. A tree in full bearing will ripen from eighty to two hundred nuts a year. Each nut is enclosed in a thick fibrous husk. The unripe nut is lined with a soft edible albumen-like jelly, within which are one or two pints of a clear liquid, which is refreshing and nourishing. When the nut ripens, the albumen or kernel hardens and is used for food. It is often grated, dried, and sold as desiccated cocoanut. Fresh cocoanuts are imported into the United States from the West Indies, Central America, and Colombia, and are grown in Florida and California.

The ripe kernels when dried in the sun are called "copra" and are pressed to obtain cocoanut oil. Copra is one of the principal exports from the islands of the Pacific and from other places where the tree is common.

COCOANUT OIL

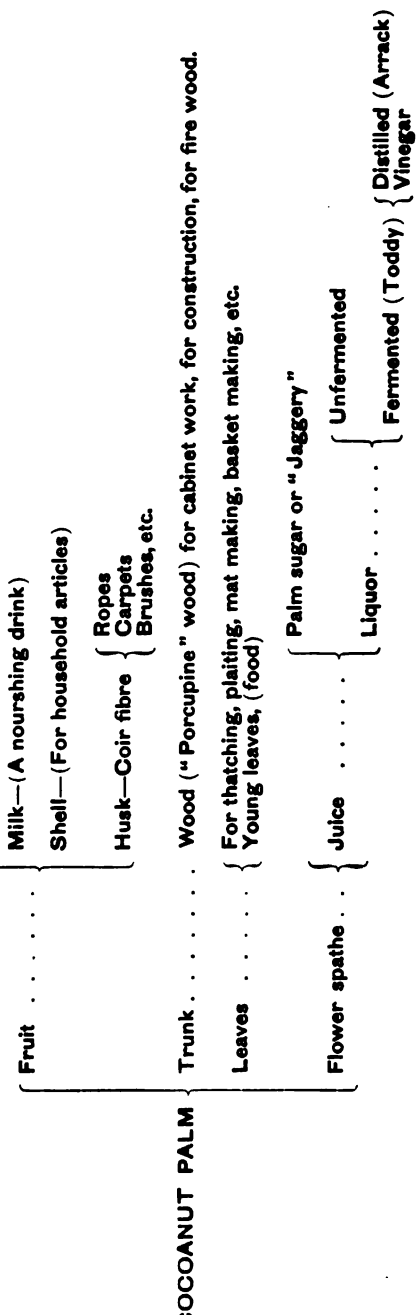
Cocoanut oil is used throughout southern and southeastern Asia and the adjacent islands as a cooking and illuminating oil, as well as for anointing the body, and for minor purposes. For lighting, the natives put it into a small dish or open vessel and dip in it a piece of cotton or loosely twisted fiber, one end of which extends over the edge of the dish and is lighted. In Europe and America it is used for making soap and candles and for cooking. Cocoanut oil is liquid at temperatures above 65° F. Below this it is a white solid, much like lard in appearance. In Ceylon and other hot countries it can be pressed from cocoanut kernels without the aid of artificial heat, but in temperate climates copra must be heated when the oil is extracted. The copra is pressed either in crude native mills or else in powerful machines, which squeeze out the oil, leaving behind cocoanut oil cake, useful for cattle food.

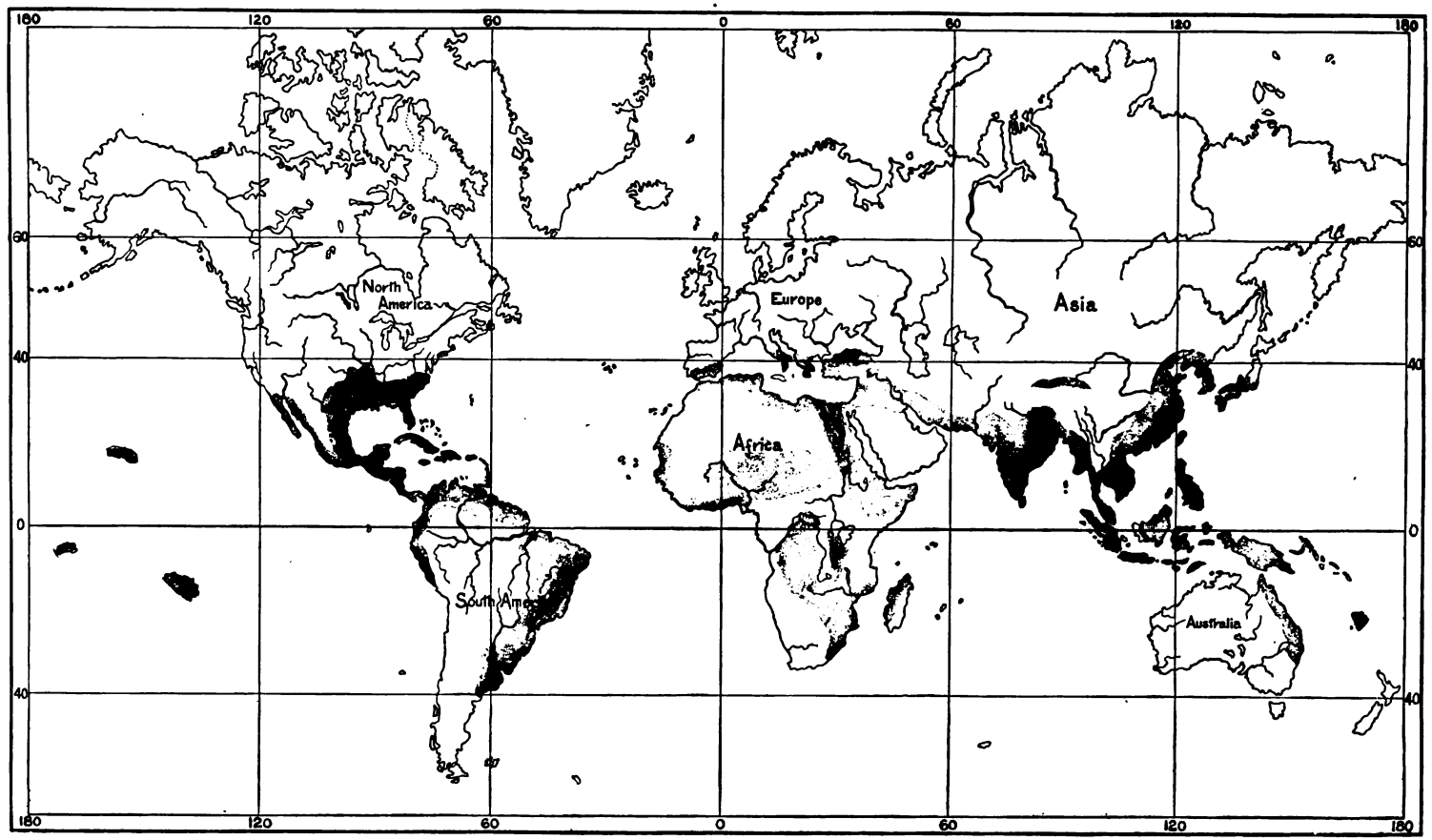
Cocoanut shells are made into cups, ladles, and other utensils by natives. The trunk of the old cocoanut tree furnishes wood which is used for house-building, for cabinet work, tool handles, and other articles, and is known in commerce as porcupine wood. The bark is used for tanning, the roots for medicine, the tender terminal bud is boiled and eaten as a vegetable, and the leaves are used for thatching, for making fans, mats, and baskets. The leaf sheaths are fibrous and are used by the natives like cloth, and by florists for ornament. The sap obtained by cutting a gash in the flower bud, when boiled down gives coarse brown sugar called "jaggery." The juice ferments rapidly, forming "toddy" or "tuba," an intoxicating palm wine, which can be converted into vinegar. "Arrack" is a stronger liquor distilled from toddy.

COCOANUT FIBER

Cocoanut fiber or coir is obtained from the thick outer husk of the nut. The husks, after removal, are soaked in water till sufficiently softened, and then the fibers are separated from each other, combed, and cleaned. Commercial coir fibers are rather coarse, stiff, and very elastic brown filaments. The best grades are straight, and up to ten inches long. The stiffest are used for making brushes; the longest and straightest for ropes of all sizes,

coarse thread, and cocoa matting; and the shorter curly fibers for stuffing. Coir ropes are valued because they are strong, elastic, and not affected by salt water.





GEOGRAPHIC DISTRIBUTION OF

COTTON

LUFFA

Luffas, or vegetable sponges, are the cleaned fibrous parts of the ripe fruit of the dish rag vine (*Luffa* species) of the gourd family. They are exported from Japan.

OAKUM

Oakum is prepared from the short waste fibers obtained by picking to pieces old cordage. It is treated with tar to make it flexible and is used to caulk the seams of vessels. When specially prepared to make it antiseptic, it is employed in surgery for dressing wounds.

COTTON

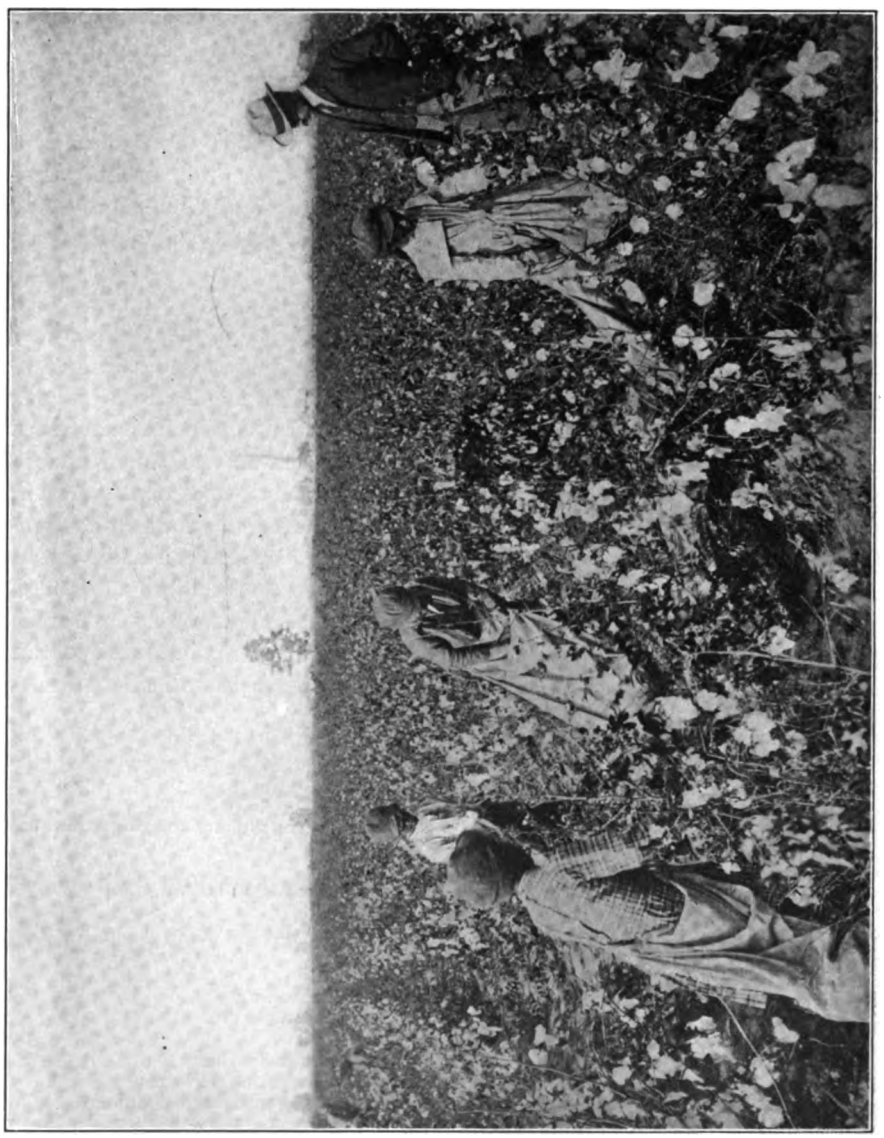
Cotton, the most important vegetable fiber, consists of the seed hairs of the cotton plant (*Gossypium* species). It is cultivated in most tropical and subtropical countries, and has been used since the most ancient times. About three fourths of all the cotton produced annually is grown in the south Atlantic and Gulf states of the United States. India, Egypt, China, Brazil, and Asiatic Russia are important producers.

The individual cotton fiber is a single, elongated, flat, twisted cell, which grows out from the seed. It is not a bundle of cells, as in the case of fibers of flax, hemp, and other basts. The fibers vary in length in different cultivated varieties, thus Sea Island cotton has the longest staple, from an inch and three fourths to a little over two inches; Egyptian cotton fibers are about an inch and a half long; Brazilian cotton is a little shorter; American upland cotton, the most common variety grown, has a staple of about an inch; and Indian cotton is still shorter. Sea Island cotton grows along the Atlantic coast of South Carolina and Georgia and on the adjacent islands. It is used for making the finest yarns, threads, laces, and cambrics. Rough Peruvian cotton closely resembles wool and is used for mixing in woolen fabrics. Egyptian cotton, on account of its long staple, is imported to this country in considerable amount, being used for fine yarns and goods, especially in hosiery and underwear.

THE COTTON PLANT

- **Cotton**
  - Yarn . . . . . → Rope; Fabrics (muslin, calico, gingham, etc.)
  - Batting
  - Absorbent cotton
  - Nitro-cellulose → Explosives (gun cotton, etc.); Celluloid; Artificial silk
- **Seed**
  - Cattle food
  - Oil . . . . . → Table oil; Fat for cooking; Soap, candles, etc.
  - Oil cake—meal (cattle food and fertilizer)
  - Hulls (paper stock, cattle food, fuel, fertilizer)
  - Linters, for cheap yarns, batting and nitro-cellulose
- **Stalk** . . . Can be used for paper making and contains a bast fiber

The cotton plant usually grows to a height of only two to four feet, but in places free from frost some varieties grow fifteen feet high. After cotton is picked from the bolls by hand, it is ginned, or freed from the seeds. In



PICKING COTTON ARKANSAS

a cotton gin, seed cotton is held in a box with a grating at one side. Through this grating project a number of steel discs, notched on the edges and called saws. When the saws rotate, the fiber catches in the teeth and is pulled away from the seeds. The fiber is blown from the saws through pipes, to a cotton press, where it is baled. Raw cotton in bales is shipped from the gins and market towns to the cotton mills. Liverpool, the largest foreign cotton market, practically sets the price for cotton the world over. The greatest centers of cotton manufacture are located in Lancashire, England; the New England states, the Carolinas, and Georgia. Germany, Russia, India, Japan, France, and other European countries are also important cotton consumers.

Within the past one hundred and twenty years the manufacture of cotton has progressed from the condition where the work was done almost entirely by hand, to the present state, where it is better done by perfected machinery. In a mill, the cotton bales are opened by a machine, and the fibers pulled apart and spread out. In various other machines, they are picked and cleaned from all dirt and leaves, and carded by passing through rollers covered with steel wire points, which comb the fibers so that they lie parallel. The fibers are first loosely twisted into a "roving," which is wound on spools and from these is spun by a "mule jenny" into yarn or thread. Yarns are woven in power looms into cloths of different kinds and qualities, such as muslin, silesia, cheesecloth, cambric, duck, canton flannel, India linon, etc. Calico is made by printing designs on plain cotton goods. Gingham is woven of cotton threads of different colors. Cotton threads are frequently woven with threads of silk or wool into mixed goods. When cotton is "mercerized" (treated with a solution of caustic soda) the fibers shrink somewhat, become stronger, are easier to dye, and acquire a silky luster. This treatment is applied to cotton either in the yarn or cloth, usually the former, and results in beautiful glossy fabrics. Other fibers, such as flax, are sometimes mercerized. Cotton fabrics are often stiffened and given "body" by starch, dextrine, or gum arabic.

When cotton is ginned, many short fibers remain attached to the seeds. These, down to the very shortest, are removed by special gins and constitute "linters," which are used for mixing with other cotton in spinning cheap yarns, and for making into wadding.

COTTON SEEDS

Cotton seeds, after the fiber is cleaned from them by the gin, are hulled, and the meats or kernels are ground up and pressed by hydraulic machinery, yielding fifteen to twenty per cent. of oil. The hulls are used for fuel, for paper-making and for feeding stock. The oil is purified by the addition of a small amount of alkali, usually caustic potash, and is used for food and for cooking, as a substitute or adulterant for olive oil, in making oleomargarine, for soap making, candle making, lubricating, etc. The addition of the alkali causes the impurities and coloring matters to sink to the bottom with some saponified oil, which is called "crude cotton oil foots" and is the base of some soaps. After the oil is pressed from cotton-seed kernels, the remaining material has

the form of hard sheets less than an inch thick, called oil-cake or press-cake. These are ground up into meal, which is used for feeding cattle, and as a fertilizer. The cotton seeds themselves are used in large amounts for cattle food. The comparatively recent development of the cotton oil industry has added greatly to the profit in cotton growing.

A small insect, the boll weevil, has caused great damage to growing cotton in Mexico, Texas, and the southwest. It lays its eggs in the young buds and bolls, and the larvae eat and destroy the cotton. Many methods are being tried to destroy this insect or prevent its ravages.

SILK COTTON

Silk cotton or vegetable silk consists of the hairs from seed pods of various trees and plants. The most common commercial silk cotton is "Kapok" from the pods of a large tree (*Ceiba pentandra*) which grows throughout the tropics. Java furnishes most of this fiber which is on the market. It is used for stuffing pillows and in upholstery. Similar fibers are obtained from other trees (*Bombax ceiba*, *Ochroma lagopus*, etc.) and also from the common milkweed. Silk cotton differs from true cotton in that its cells are thin-walled, straight and smooth, while those of true cotton are thick-walled, have corded edges, and are twisted many times throughout their length. These twists cause one fiber to interlock with another in spinning. Because of the smoothness and straightness, silk cotton cannot be spun.

PAPER

Paper can be made from almost any kind of fibrous material. The stocks principally used are the woods of certain trees, a few kinds of bark, the poorest qualities of such fibers as cotton, flax and jute (including the waste from mills which use these fibers), cotton and linen rags, worn-out ropes, bamboo, and straws of wheat, rice, esparto, or other grasses. The finest papers are made from linen rags, but all of the cheap grades are made of wood. In this country three quarters of all wood pulp is made of spruce, and about one eighth of poplar wood. Massachusetts, New York, Maine, Wisconsin, and Pennsylvania are the most important paper-making states. The chief paper-making countries are the United States, England, Germany, France, Austria, and Belgium. In making paper, the material used is cut into small pieces and cleaned by washing, bleaching, and chemical treatment, from the cementing and coloring materials which may be combined with the fibrous part. The pulp obtained consists of the more or less pure fiber (cellulose) and may be bleached perfectly white or dyed any desired color. The cheapest grades of wood pulp are made by grinding the wood, but in these the fibers are broken short, and they are used only in low grade papers. The pulp is fed automatically on a moving belt made of wire cloth and usually has added to it "sizing" in the form of hard resin. The soft sheet of pulp is then pressed between felt rolls, dried, and passed through a series of heated metal rollers, which compact the fibers and give the paper a smooth, hard surface. Many papers and cardboards are "filled" or "loaded," that is, they have kaolin, talc, or some other powdered mineral substance added to the pulp to make them heavier and denser. Blotting paper has no sizing added to it and is not "calendered" by the heavy rollers.

Papers are often made to imitate leather and other materials. Wood pulp and paper pulp mixed with glue or sizing (papier-maché) is sometimes moulded under pressure into car wheels and other articles which possess a surprising amount of strength and durability.

ARTIFICIAL SILK Artificial silk is made from very pure paper stock. Cellulose prepared from wood or cotton is treated with nitric acid, forming what is called nitro-cellulose. This is then dissolved in a mixture of ether and alcohol. This solution is driven through very fine tubes forming slender threads from which the alcohol and ether evaporate away at once, leaving the nitro-cellulose as a fine lustrous fiber. Subsequent treatment with ammonium sulphide or other agent de-nitrifies it and renders it less inflammable.

CELLULOID Celluloid* is a substance artificially prepared from cellulose. The pure cellulose similar to that used in making artificial silk is acted on by a mixture of nitric and sulphuric acids, being converted into nitro-cellulose. This is thoroughly mixed with melted camphor, by grinding in heated rollers. It dissolves in the camphor, forming a tough plastic mass, which is then moulded by pressure into any desired form. It is made in sheets by planing off from solid blocks in a machine similar to a veneering machine. Celluloid is made in many colors and is used as a substitute for hard rubber, tortoise shell, and ivory, for knife handles, brushes, combs, and other toilet and fancy articles, for billiard balls, piano keys, collars and cuffs, and articles of jewelry imitating coral and jet.

STRAWS Straws, the stems of grains or other grasses, or of reeds or rushes, are used for hat making, basketry, mattings, chair seats, brooms, thatching, ropes, and in paper-making. The commonest are those from rye, wheat, barley, rice, esparto, broom corn, rushes and reeds. Twigs of willow and roots are also used for basketry.

SPANISH MOSS Spanish moss grows from South Carolina to Argentina, hanging in dense masses from the branches of trees. The outer cuticle is removed from the plant (*Tillandsia usneoides*) by machinery and the remaining fiber, which resembles horse hair, is used for upholstery. The unprepared moss is used as a packing material for fruit and glass.

ZACATON Zacaton, Mexican whisk, or broom root, is the root of a large grass (*Epicampes macroura*) which grows in the cool districts of Mexico. It is used in making brushes.

Crin Vegetal is the shredded leaves of a small palm (*Chamaerops humilis.*) It is imported from Algeria in the form of ropes, and when opened up is used in upholstery.

Panama Straw, used in making Panama hats, is the split leaf of a palm tree (*Carludovica palmata*).

RATTAN Rattan comes from the East Indies. It is the stem of climbing palms (*Calamus* species). These palms are sometimes many hundred feet in length and usually have strong hooked

* "Celluloid" is a trade name registered by the Celluloid Co.

spines on the stems and leaves. Rattan owes its value to its strength, its flexibility, and its uniform size. In Asia it is used to an enormous extent for basketry and ropes. It is imported for use in making furniture, baskets, canes, whips, etc. In preparing rattan "cane" for market, the natives clean off the leaves and outer cuticle by pulling the stems through a notch in a tree or board. After this dressing, rattan is cut into lengths and tied in bundles for sale. The smooth "bark" of rattan is split off by machinery in long slender strips and is used in chair-caning. Peeled rattan is used for stiff brushes, and for basketry.

BAMBOO

Bamboo is the largest plant of the grass family (*Bambusa* species). It is found in tropical countries, but is most common in Japan, China, India, and the East Indies. Its stem sometimes reaches a foot in diameter and its height is occasionally a hundred feet. In its native countries it is used for house building and all sorts of construction purposes, for making furniture, agricultural implements, canes, fishing rods, and innumerable other things. In China, bamboo is used in paper-making. The soft tender shoots just appearing above ground are sometimes cooked and eaten in both Japan and China.

Bamboo splits readily into long flexible strips, which are woven into basketry of all kinds and used for making stiff brushes.

WOODS.

Lumber is the product of the sawmill after the trees of the forest have been cut into logs and hauled to the mill on wagon, rail or river. Beams, scantling, rough boards and lath are used in framing, sheathing and rough construction, or they are sent to the planing mill and there surfaced, edged and dimensioned for exterior and interior finishing and higher grade construction. Rough and surfaced lumber also go to special mills and are manufactured into finished articles, such as building material, furniture, wagon stock, turnery, implements, boxes, cooperage and patterns. Wood is used in the log for posts, telegraph poles, railway ties, sills and bridging timber; or is split into shingles and fencing. The consumption of wood for fuel throughout every forested country of the world is enormous, and the extraction of tar, gums, resins, tans and dyes from wood and bark, constitutes important industries. The woods of cone-bearing or needle-leaf trees are often called "softwoods," while those of the broad-leaf trees are classed as "hardwoods." These are not, however, properly distinguishing terms, as many coniferous softwoods are hard and many of the common broad leaved woods are nearly as soft as white pine.

Woods may be compared by their relative weight, hardness, strength, elasticity and durability, and by color and grain. Yellow, brown and red are the predominating colors. The grain varies from straight lines of growth to what is termed "curly" or "figured" grain, due generally to uneven or twisted growth.

Most of the important woods of the United States are exported to Europe, some extensively because superior to, and cheaper than similar woods

of that region. Many of the woods of the Pacific coast are also exported to Japan, China and the islands of the Pacific.

NEEDLE LEAF WOODS.

Needle leaf or coniferous woods constitute by far the greatest amount of lumber used. The trees, with the exception of the junipers, bear distinct cones, and, excepting bald cypress and the larches, have evergreen or non-deciduous foliage. The woods include the softest, lightest and most easily worked kinds and may be characterized as containing resin and having no visible pores on the end grain.

SOFT PINES The soft pines are comparatively free from resin, light, easily worked, soft and not strong, suitable for the cabinet maker, joiner, carpenter, pattern maker, and a variety of special purposes. The most important of them is white pine.

White Pine, one of the most valuable timber trees of the world, was formerly more used than any other for general construction in the United States and was largely exported. It forms great forests in Canada and the northeastern United States and also grows throughout the Appalachian Mountains to Georgia. It is also called New England, Michigan and Weymouth Pine (*Pinus strobus*). Trees grow 80 to 100 ft. high, the trunks 3 to 9 ft. in diameter. White pine is now becoming scarce, and the lumber in A1 grades costs nearly as much as good mahogany.

Sugar Pine of the northwestern United States and British Columbia, grows 100 to 300 ft. high, the trunk 12 to 30 ft. in diameter. It is exported to China, Japan and Hawaii.

Western White Pine of the Northwest is also a large tree, and Rocky Mountain White Pine is the principal timber tree of Utah and Nevada.

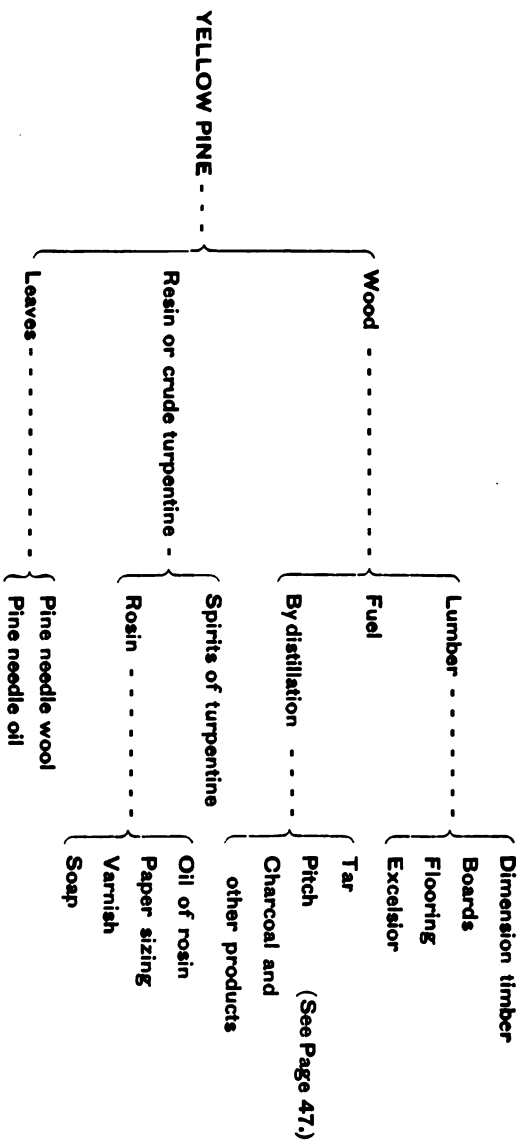
In the western United States and in Mediterranean countries the seeds of various Nut or Piñon Pines (*Pinus edulis*, etc.) are collected for food.

YELLOW or HARD PINES The Yellow or Hard Pines are resinous, heavy, hard, strong, durable, and comparatively difficult to work. The logs are largely sawed into dimension timbers for heavy construction (piling, wharfage, bridging, sills, etc.), into boards for building and extensively into flooring. The inferior kinds are used for boxes, crates, etc.

The following are the important varieties:—

Longleaf Pine is the most valuable yellow pine tree, yielding the best grades of lumber. It forms exclusive forests throughout the southern Atlantic and Gulf seaboard of the United States from North Carolina to eastern Texas. It is also called Georgia, Hard and Southern Pine and Turpentine tree (*Pinus palustris*). The trees occur from 60 to 90 ft. high and the trunks from 2½ to 4 ft. in diameter.

Shortleaf Pine is the principal pine timber tree of Missouri, Arkansas, and Kansas. It is scattered throughout the eastern United States. The tree is also called Bull and Spruce Pine (*Pinus echinata*). It grows to about the same size as the longleaf and the wood is not distinguishable.



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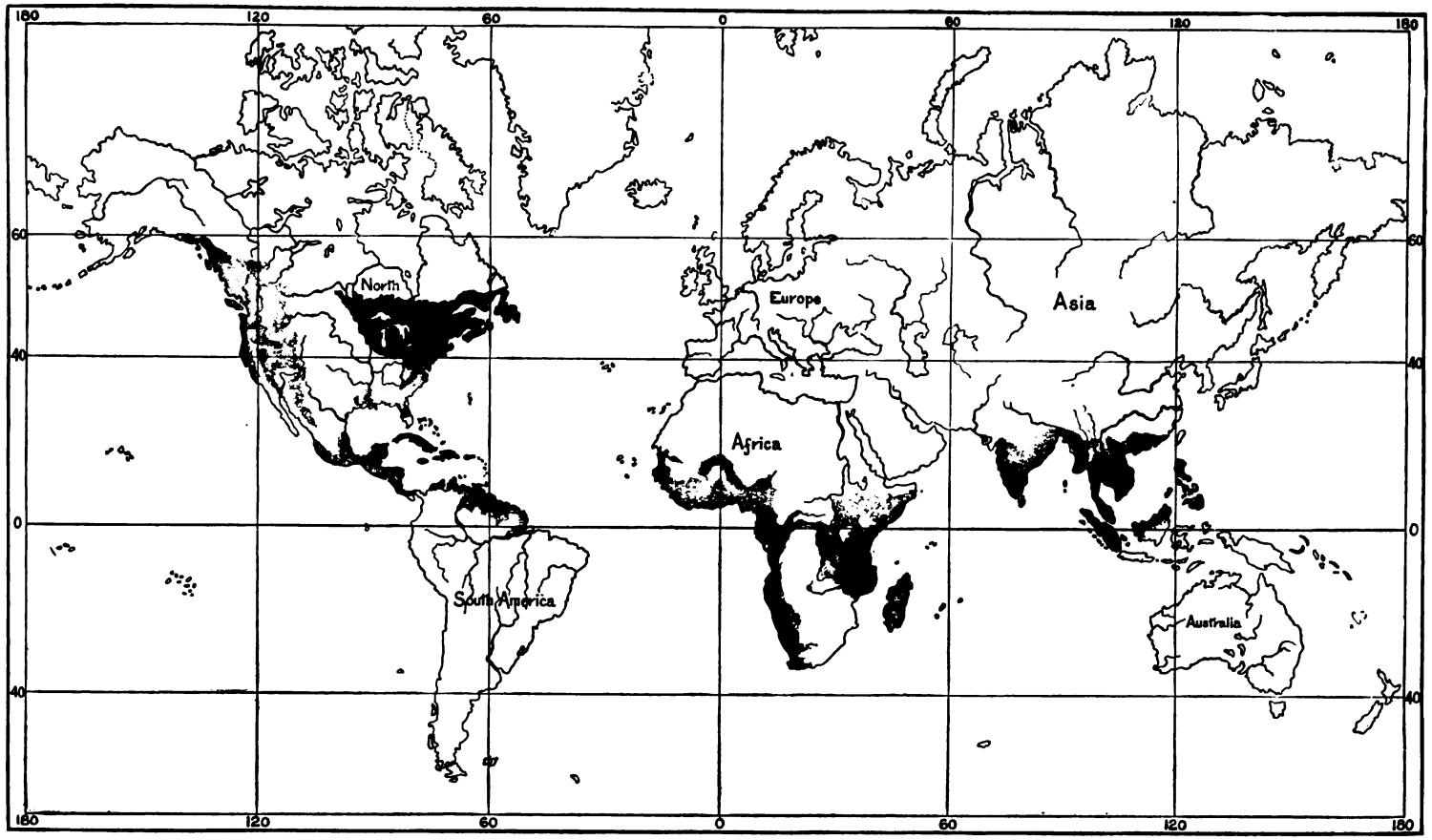


GEOGRAPHIC DISTRIBUTION OF

WHITE PINE
HEMLOCK

YELLOW PINE
BALD CYPRESS

DOUGLAS FIR

EBONY

Cuban Pine is found near the coast from Charleston, S. C., to Mississippi and also in the West Indies and Central America. It is called Slash, Swamp, Meadow and Pitch Pine (*Pinus cubensis*). The trees are somewhat larger than the longleaf pine and the wood is hardly inferior.

Loblolly Pine is scattered, or in groves throughout the eastern United States south of Maryland. Lumber known to the trade as North Carolina pine is cut almost entirely from this tree (*Pinus taeda*). The names Old Field, Rosemary, Virginia, Sap and Slash Pine are also applied to it and the lumbermen frequently confuse it with the shortleaf. The trees grow from 80 to 150 ft. high, with trunks from 3 to 5 ft. in diameter. The wood is generally inferior to longleaf pine.

Western Yellow Pine is a large tree, common in portions of the Rocky Mountains, the Coast Range and the intermediate valleys from interior British Columbia to Mexico. It is also called Bull Pine (*Pinus ponderosa*).

Red Pine grows in southern Canada, and the northern United States. It is cut and marketed with White Pine. It is called incorrectly Norway Pine.

Northern Pine of Europe and northwestern Asia is also called Yellow Deal, Redwood, Scotch, Memal, and Dantzic Fir. The wood is similar to the yellow pine of the United States.

CRUDE TURPENTINE

Crude turpentine is a semi-fluid, sticky resin exuded from wounds made in the trunks of several trees belonging to the Pine family. It is produced chiefly in the United States, Finland, Russia, Austria, France and India. In the United States it is obtained almost exclusively from the longleaf or yellow pine tree (*Pinus palustris*). Turpentine is usually obtained in the following manner: the trees are wounded by removing a wide strip of bark on one side and cutting below this into the wood of the tree a pocket-like cavity known as a "box." The wound thus made discharges the fluid into the pocket, which holds two or three pints and is filled in about ten days. The turpentine is then dipped out and the wound re-opened to stimulate a further flow. By more modern and careful methods the turpentine is caught in vessels which are hung on the trees, which are thus not ruined by the removal of so large a strip of bark and are not weakened by the cutting of the "box." In this way, the yield of turpentine is increased and the life of the tree lengthened. The crude turpentine, which consists of a resin dissolved in a volatile oil, is put into a still with water and distilled. The steam, in going over in the still, carries the volatile oil with it, and the distillate is allowed to cool in a vat. The water and oil separate into two layers, and the latter is drawn off in barrels for market. It is known as spirits of turpentine, or oil of turpentine, and is largely used for dissolving resins for varnishes and for mixing paints. It is used in medicine and in veterinary practice as a liniment.

ROSIN

The residue remaining in the still is a solid substance of an amber or blackish-brown color known as rosin or colophony. The color varies according to the purity of the rosin and the degree of heat used in its preparation. In this country three grades are in the market: "virgin," "yellow dip," and "hard." Virgin rosin is made from the first

turpentine that exudes after the tree is "boxed." It is of a very light yellow or amber color. The greater part of the crude turpentine furnishes yellow dip. Hard rosin is almost black in color and is made from the scrapings from the tree after the turpentine has become too hard to run.

Rosin is used in making soaps and varnishes and for sizing paper. It is used by tinners and plumbers as a flux for their solder; by founders for giving tenacity to their cores; for making medicinal plasters and sealing wax and for rubbing on violin bows. It is used in ship caulking; as an adulterant of fats, waxes, and mineral oils; and for mixing with tallow to make common candles. When rosin is heated in a retort it is decomposed into certain gases, liquids, and pitch (see also Tar). The liquid distillate is chiefly rosin spirit and rosin oil, the former resembling oil of turpentine. These are used in varnish making and for "rosin grease"—a lubricant.

Pine Needle Wool, used for stuffing mattresses, pillows and for making mats and rugs, is made from the leaves of the longleaf, Cuban, European and western yellow pines, and from these species Pine Needle Oil, used medicinally, is also made.

SPRUCE

The Spruces are valuable trees furnishing soft, light, very white wood, the heart not easily distinguishable from the sap. The trees are of northern growth, and wide distribution. The wood is used commonly for construction and more than any other kinds for making paper pulp.

White Spruce, since the scarcity of white pine, has become an important timber tree. It is not found south of the 40th parallel in the United States, but forms vast forests throughout Canada as far north as Labrador and Alaska. The trees (*Picea canadensis*) grow 60 to 150 ft. high, the trunks 3 to 5 ft. in diameter. The wood has a satiny lustre.

Black Spruce is very similar to the preceding with nearly the same range (*Picea mariana*).

Red Spruce is a somewhat smaller tree (*Picea rubra*) growing as far south as North Carolina, on the high peaks of the Alleghanies. The wood is not distinguishable from white spruce.

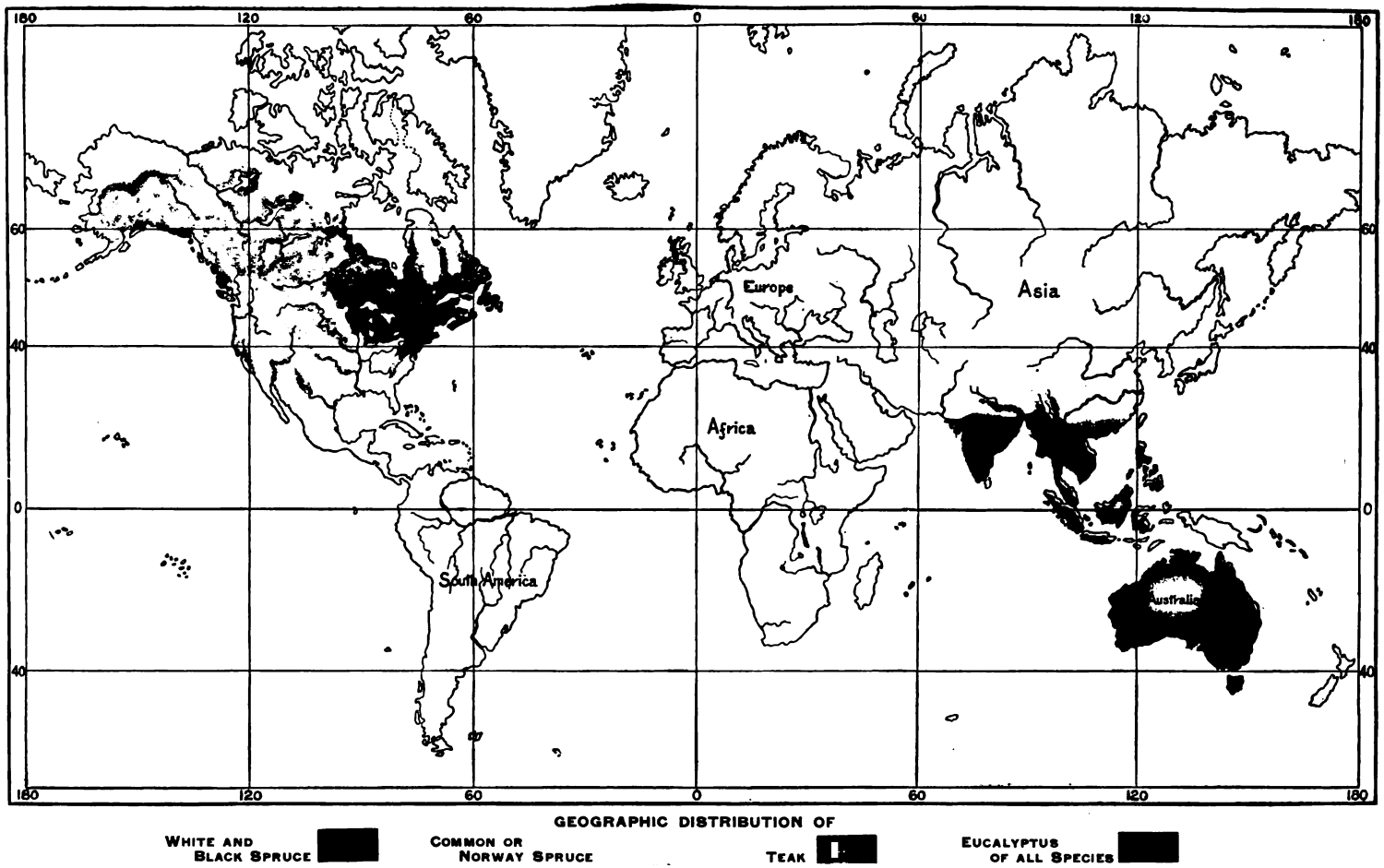
Tideland Spruce is one of the largest and most important timber trees of the Pacific northwest. The wood is used for boat building, cooperage, woodenware, shooks, excelsior, interior finish, fencing, piling, carpentry, furniture, and also for paper pulp. The trees (*Picea sitchensis*) grow only near the coast, from Alaska to California, and reach a height of 200 to 300 ft. and 4 to 20 ft. in diameter of trunk.

Norway Spruce is one of the most useful trees of Europe, and has been extensively planted in the United States for ornamental shade.

Two other species of spruce common in the Rockies and the Northwest are cut locally for lumber. These are Engelmann's and the Blue Spruce.

HEMLOCK

The Hemlocks are trees of the first economic value, and have become more so since the scarcity of pine. The wood is splintery, pinkish white in color, coarse grained, and easily worked though tough.



GEOGRAPHIC DISTRIBUTION OF

WHITE AND BLACK SPRUCE

COMMON OR NORWAY SPRUCE

TEAK

EUCALYPTUS OF ALL SPECIES

Eastern Hemlock is used more than other trees for framing timbers, scantling, sheathing, etc. It occurs in southeastern Canada and the northeastern United States, and grows to a height of 60 to 80 ft. with a trunk from 2 to 3 ft. in diameter (*Tsuga canadensis*).

Western Hemlock furnishes a wood superior to that of the eastern species. It is used also for wainscoting, stair work, and turning. The trees grow from 100 to 150 ft. high, the trunks 2 to 8 ft. in diameter (*Tsuga heterophylla*).

FIR

The Firs, with the exception of two species, furnish wood that is coarse grained and inferior to that of the other conifers. It is used mainly for light construction, packing cases, paper pulp, and charcoal.

Douglas Fir is the most abundant and useful tree of the Pacific coast, and is found throughout the Rocky Mountains. The wood is used for heavy construction, bridging, piling, railroad ties, sash, doors, flooring, shipbuilding, furniture, and especially for masts and spars, for which it is extensively exported. It is also called Douglas Spruce, Oregon Pine, Red Fir and Yellow Fir (*Pseudotsuga mucronata*). A large tree, from 100 to 300 ft. high, with a trunk 2 to 15 ft. in diameter, it sometimes furnishes logs clear of limb 90 feet long.

Noble Fir yields a wood that is hard, strong and elastic. The tree is peculiar to the Cascade and Coast ranges of Oregon. The wood is valuable for general construction, boat-building and furniture. It is also called Red Fir (*Abies nobilis*). The tree grows 200 to 300 ft. high and 3 to 11 ft. in diameter of trunk. The wood is light brown, streaked with red.

White Fir, common in the northwest United States and British Columbia, is of two species, one growing on the higher mountains, and the other near the coast and in the valleys.

Magnificent Fir, the largest tree of the genus, furnishes lumber for sills, framing, woodenware, and cooperage. It grows in southwestern Oregon and northern California, with a height of 250 to 300 ft., and a diameter of from 6 to 12 ft.

Balsam Fir is relatively a small tree common throughout eastern North America as far south as the mountains of Virginia. The most valuable product from this tree (*Abies balsamea*) is Canada Balsam, used medicinally and in the arts.

Silver Fir of Europe is used for many purposes, and because of its sonorous quality is imported as "Swiss Pine" for the sounding boards of pianos and violins.

CALIFORNIA REDWOOD

California Redwood is one of the largest trees of the world and the most valuable on the California coast. It is closely related, and has wood very similar, to the famous big trees of California. The wood is especially valuable for shingles, tanks, coffins and light construction. The trees (*Sequoia sempervirens*) grow from 200 to 300 ft. high, with a diameter of trunk from 8 to 22 ft.

The wood is very soft and light, of a dull red color, straight grained and does not warp or shrink readily.

LARCH

The Larches furnish wood that is strong and very durable, moderately hard, straight grained, and not unlike yellow pine, but less resinous. The wood is used for ship timbers, telegraph poles, railroad ties, boat knees, flooring, framing, posts, etc. The trees grow from 80 to 150 ft. high, with trunks 2 to 5 ft. in diameter.

Eastern Larch is found in Canada and the northeastern United States. It is also called Tamarack and Hackmatack (*Larix americana*).

Western Larch is abundant in British Columbia and the Northwest. The name Tamarack is also applied to it (*Larix occidentalis*).

European Larch grows in the Alps of central Europe and in Lapland, Norway and Siberia. The wood is used especially for piling on account of its durability.

CYPRESS

Cypress is a rather general term for many woods allied to, or identical with the Cedars. The wood is distinctly grained, soft, coarse, and used for cabinet work, interior finish, shingles, framing, posts, etc.

Bald Cypress is common along the southern coast of the United States, from Delaware to southern Texas, and in the lower Mississippi Valley. The tree (*Taxodium distichum*) grows from 80 to 140 feet high, with a diameter of trunk 5 to 12 feet.

Yellow Cypress grows near the coast from Sitka to Oregon. It is also called Alaska Cedar (*Chamaecyparis nootkatensis*).

Lawson's Cypress of Oregon and northern California, growing near the coast, is also called Port Orford Cedar, and Ginger Pine (*Chamaecyparis lawsoniana*). It grows from 100 to 200 ft. high and has a trunk from 2 to 6 ft. in diameter.

Cypress of the Old World is a common tree of the Mediterranean region of Europe, Asia Minor and Persia. Egyptian mummy cases and ancient gates made of this wood were sound after 1100 years.

Cypress Pine is a valuable tree of Australia, having a fine figured wood, with a camphor-like fragrance, used for furniture.

Indian Cypress grows in the Himalaya Mountains and furnishes brown, hard wood used for building.

WHITE CEDAR

The White Cedars are so called to distinguish the wood from the Red Cedars or Junipers. The color of the heartwood, however, may be grayish pink or brown. The trees are cut largely for posts, telegraph poles, fencing and split shingles and are sawed into lumber for tanks, boats and wooden ware. The wood is very fragrant.

Incense Cedar is a common tree of Oregon and California. The trees (*Libocedrus decurrens*) grow from 100 to 150 ft. high, and 3 to 7 feet diameter of trunk.

Canoe Cedar is common in the northwest from Alaska to California and Montana. It is also called Giant and Red Cedar (*Thuya plicata*). The heart wood is reddish brown.

Common White Cedar grows along the eastern coast of the United States from Maine to Mississippi. The trees (*Chamaecyparis thyoides*) grow 50 to 70 ft. high with trunks 2 to 3 ft. in diameter.

Arbor Vitae, a small tree common in Canada and the northeastern United States is less valuable. It has become a common lawn ornament and hedge tree.

Deodar is one of the chief timber trees of northwest India. Cedar of Lebanon occurs in southwest Asia. Atlas Cedar grows in the mountains of north Africa.

RED CEDAR The Red Cedars are widely distributed trees commonly called Junipers. The wood is fragrant, soft, light, and easily cut, and is used for lead pencils, woodenware, chests, cabinets and fence posts.

Common Red Cedar is found all over the eastern and central United States and is notably the lead pencil tree. It is also called Red Juniper, Savin and Pencil Cedar (*Juniperus virginiana*). It occurs as a small shrub or grows as high as 100 ft. with a trunk 4½ ft. in diameter. The wood is deeper red than that of any other species, and, when straight grained, of greater value.

Western Juniper is of two very similar species common in Washington, Oregon and California. The trees grow 50 ft. high and as large as 3 ft. in diameter of trunk, but are often only low shrubs.

THE BROAD LEAVED WOODS.

The broad leaved woods are from those trees that are generally termed deciduous, although many of them are evergreen. They are of greater variety and wider distribution than the coniferous trees and the woods are more varied in grain, color and texture. The extremes are reached in very white, jet black, rich red, and bright yellow, and they include the hardest and strongest woods. They are not resinous.

The softer broad leaved woods of the most important species are as follows:—

TULIP POPLAR Tulip Poplar, a tree of the first economic importance and the largest tree in the eastern United States, is common in the Mississippi Valley and the Atlantic States south of Vermont. The wood is used for a great variety of purposes in which it now largely takes the place of white pine. It is also called Tulip tree and Whitewood (*Liriodendron tulipifera*). It grows to a height of 125 to 250 ft. with a diameter of trunk from 6 to 14 ft. The wood is variable, generally soft, easily worked, not durable, color yellowish white, shading to greenish or brownish.

LINDEN The Lindens are important trees furnishing soft, light, smooth wood of a light color used for general construction and for many special purposes, such as carriage bodies, handles, cooperage, paper pulp and gunpowder charcoal.

American Linden is common throughout southeastern Canada and northeastern and central United States. It is also called Basswood, Lime, Bee tree, Lin and Whitewood (*Tilia americana*). The trees occur from 70 to 80 ft. high with trunks 3 to 4 ft. in diameter.

White Basswood, a tree found in the central United States, is very similar to and commercially confounded with the foregoing. It is also called Wahoo (*Tilia heterophylla*).

European Linden is of three species common in Europe. These are also called Lime trees or Lins. The wood is used for carvings, druggist boxes, etc. Linden bast fiber prepared from the inner bark is used for cordage, mats, bagging, and fishing nets.

COTTONWOOD Cottonwood, similar to linden, is used for much the same purposes, and very extensively for paper pulp. It is found throughout the eastern and central United States, reaching its greatest development in the south and west of the Mississippi. It is also called Carolina and Necklace Poplar (*Populus deltoides*). The trees grow from 80 to 175 ft. high and from 4 to 8 ft. in diameter of trunk. The wood is soft, fibrous, light, and grayish white, or brown.

The close grained, typically hard woods (in which the grain pits are not conspicuous) are of many important species.

MAPLE The Maples furnish wood that is compact, tough, susceptible of a fine polish and often beautifully grained or figured, being then variously called "curly," "bird's eye," "blister," "landscape," and "fiddle back" maple. The wood is extensively used for veneering, flooring, furniture, the backs of violins, wooden bowls, shoe lasts, rulers, tool handles, and inlay work. It is especially valuable for charcoal and potash.

Sugar Maple is a tree of the first economic importance in North America, growing in southeastern Canada and the northeastern states along the Alleghany Mountains to Georgia and also in west Florida. It is also called Hard and Rock Maple (*Acer saccharum*). The trees grow 50 to 100 ft. high with trunks 2 to 4 ft. in diameter. The wood is hard and most commonly furnishes the figured forms. Maple sugar is chiefly taken from this tree. The sap is drawn off by tapping the trunks in early spring and is then boiled down until it is of the desired consistency.

Red Maple is a similar tree growing throughout the eastern and western United States and Canada. It is also called Swamp Maple (*Acer rubrum*). The wood is darker and less valuable than sugar maple.

Silver Maple is also common throughout the eastern and central United States and Canada. It is also called Soft Maple (*Acer saccharinum*). The wood is inferior and less used than sugar maple.

Broad Leaved Maple is a valuable tree common on the Pacific coast from Alaska to California. It is also called Oregon Maple (*Acer macrophyllum*).

Common Maple of Europe and northern Asia is a valuable cabinet wood.

Norway Maple of northern Europe and Switzerland is not commercially distinguished from the preceding. It is extensively planted in the United States as a shade tree (*Acer platanoides*).

Sycamore Maple of Europe and western Asia furnishes a wood similar to and often confused with the preceding. Other species are the Himalayan Maples and the Japanese Maples used for cabinet and carpenter work.

BIRCH Several species of Birch furnish wood which is hard, strong, compact and fine grained. It is used for a variety of purposes, such as making handles, clothes pins, tools, shoe pegs, woodenware, wheel hubs, fellies, fruit baskets and boxes, veneers, furniture, and for charcoal.

Cherry Birch, the most important and generally used of the North American birches, is found throughout the northeastern United States and southern Canada and in Tennessee. It is also called Black, Sweet, and Mahogany Birch (*Betula lenta*). The wood is reddish and the trees grow from 60 to 80 ft. in height with trunks 2 to 3 ft. in diameter. Wavy or figured grain, called "curly" birch, is highly prized and shows a beautiful golden satiny lustre.

Yellow Birch, of much the same locality as the preceding, furnishes wood that is lighter in color (*Betula lutea*).

Paper Birch is similar to Yellow Birch, and is found from Labrador to Alaska and from Maine to Washington. It is also called Canoe Birch (*Betula papyrifera*). The bark of this tree is peeled off and used for making canoes, tents and fancy articles.

European Birch, of northern Europe and Asia, is very similar to American Cherry Birch. The bark is used extensively for baskets, boats, cordage, dyeing and tanning.

BEECH Beech is a valuable wood for many purposes. It is heavy, hard, strong, compact and fine grained, and of a light brown or pinkish brown color, the radiating rays being quite distinct. It is used for tools, handles, clothes pins, wagon stock, shoe lasts and for gunpowder charcoal. The trees grow from 50 to 100 ft. high, with trunks 2 to 4 ft. in diameter.

American Beech (*Fagus atropunicea*) is very common in southern Canada and eastern and central United States.

European Beech is common except in Scandinavia and eastern Russia. The wood is used largely for sabots.

SYCAMORE Sycamore (called Plane in the Old World) is a wood valued chiefly for interior decoration. It is common from Maine to Florida, and from Nebraska to Texas. The wood is light reddish brown, compact, rather hard, uneven grained, and difficult to work. When cut radially it possesses a beautiful mottled and cross banded figure

known as "lacewood" or "honeysuckle." The tree is also called Button-ball (*Platanus occidentalis*). It grows from 90 to 135 ft. high, and from 5 to 12 ft. in diameter of trunk.

Eastern Plane is found in southeastern Europe and southwestern Asia.

HOLLY Holly is a rather small tree, the very white close grained wood of which is much used for fancy articles, turnery, fret sawing, inlay work, carving and almost exclusively for picture burning.

American Holly (*Ilex opaca*) is common in certain localities from Massachusetts to Missouri and from Florida to eastern Texas.

European Holly is found in central Europe and western Asia.

The open grained hard woods (with the grain pits very conspicuous) of light color are all used for a great variety of purposes. The various shades of finished wood, in furniture, cabinet work, and interior decoration, such as "golden" oak or ash, "green oak," "antique," "old English," "Tuscan," etc., are entirely the result of fillers put on to close up the pores before the varnishes are applied.

OAKS Oaks are of many species, most of which are very useful. To lumbermen in the United States they are known as White Oak, Live Oak and Red Oak, and the species are hardly distinguished further. The medullary or radiating rays are large and conspicuous and give beautifully figured grain when "quartered," or sawed from the bark to the center of the tree, parallel to these rays. To effect this best the logs are cut in quarters before cutting into boards, whence the name. Boards cut in the ordinary manner and showing the radiating rays cut at right angles are called "plain" sawed or "straight oak."

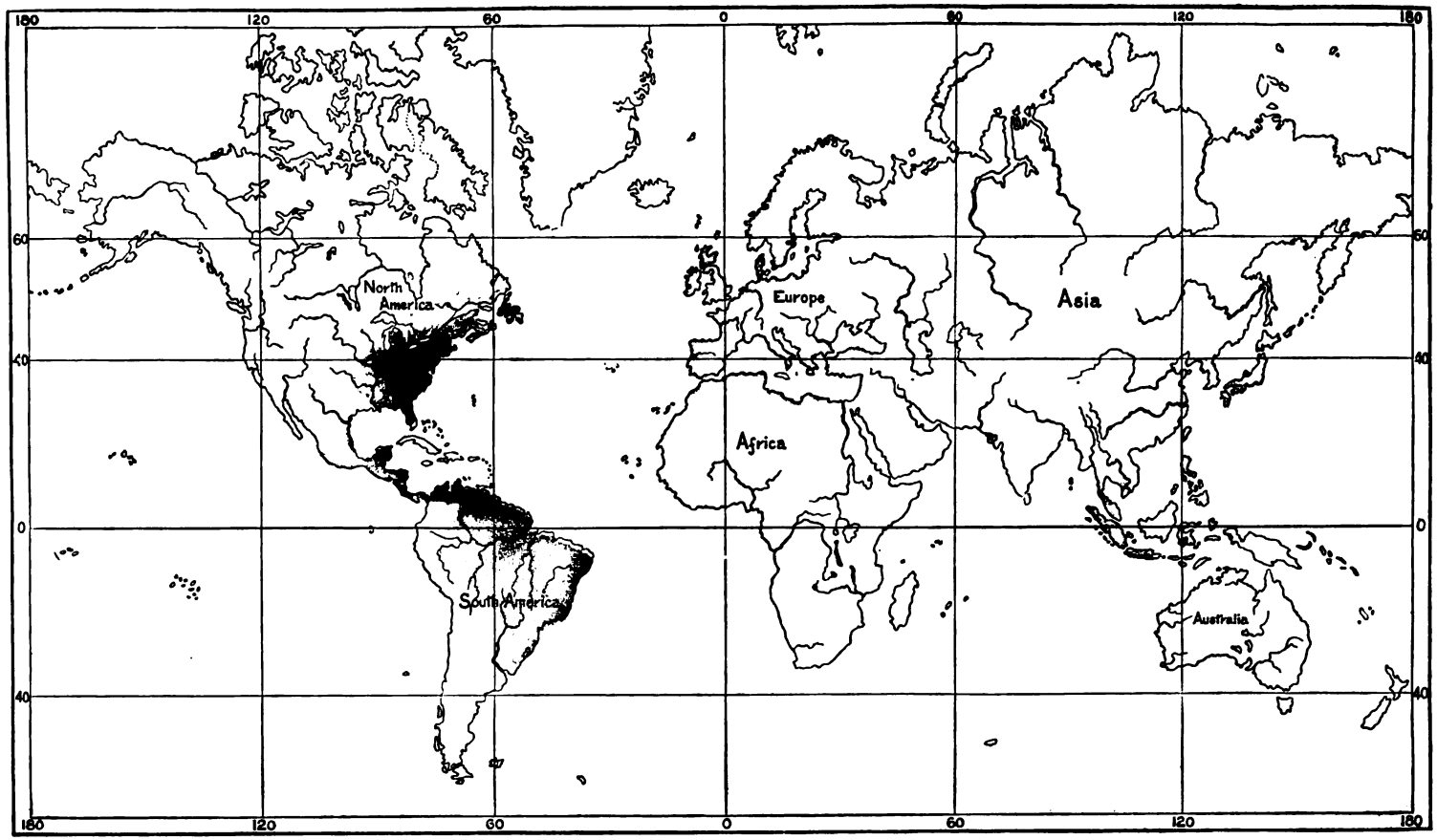
WHITE OAK White Oaks are hard, tough, strong, elastic and durable and generally of a light grayish brown with a pale pink tinge. The trees are cut for bridge and building timbers, railroad ties and posts; also for lumber for furniture, cooperage, agricultural implements, wagon stock, and especially when quarter sawn, for fine cabinet work, interior finish, flooring, etc. The white oaks are as as follows:

White Oak is common from Maine to Michigan and Missouri, and from Florida to central Texas. The trees (*Quercus alba*) grow from 80 to 150 ft. high, and the trunks from 4 to 8 ft. in diameter. The bark is used for tanning.

Burr Oak is very similar to the preceding with a somewhat more northern range. The wood is possibly harder and tougher. It is also called Mossy-cup Oak (*Quercus macrocarpa*).

Over-Cup Oak (*Quercus lyrata*) is similar and grows along the Atlantic coast from Delaware to Texas.

Chestnut Oak grows only in the eastern and central states from Massachusetts to Tennessee. From the bark and wood of this (*Quercus prinus*) and the two following species, more than from other American oaks, are made extracts extensively used in tanning.



GEOGRAPHIC DISTRIBUTION OF

WHITE OAK
CHESTNUT
BLACK BIRCH
BEECH

ROSEWOOD
JACARANDA

OLD WORLD OAKS

Yellow Oak is a small tree or shrub in the eastern United States and a medium sized tree (*Quercus prinoides*) west of the Mississippi to Kansas and western Texas.

Basket Oak or Cow Oak (*Quercus michauxii*) is common in the southern states from Delaware and Kentucky, to Florida and central Texas.

Swamp White Oak (*Quercus bicolor*) grows in the northeastern states and most commonly in the region south of the Great Lakes.

Oregon White Oak and Tanbark Oak grow from Vancouver Island to California, generally near the coast (*Quercus garryana* and *Q. densiflora*).

LIVE OAK

The Live Oaks are exceedingly hard, tough, strong, durable and difficult to work. Because of their scarcity and the small size of the trees they are used only for special purposes, such as boat-building, wagons, agricultural implements, etc.

Southern Live Oak (*Quercus virens*) grows from Virginia to Mexico along the coast and in western Texas.

Western Live Oak is peculiar to Oregon, California and southern Arizona. It is also called Maul Oak (*Quercus chrysolopis*).

RED OAK

The Red Oaks are somewhat softer, more open grained, and less durable than white oak. The heart wood is of a decided pink or light red color. They find much the same general uses as white oak and are commonly quarter sawn. The trees grow from 80 to 100 ft. high, with trunks 3 to 6 ft. in diameter.

Spanish Oak (*Quercus digitata*) grows along the coast from New York to Texas, and through the central states south of Ohio and Missouri. It is also called Red Oak. The wood is extensively used for cooperage and furniture.

Red Oak (*Quercus rubra*) grows throughout the eastern and central United States, from Nova Scotia to Texas.

Black Oak is common from Maine to Florida, and Minnesota to Texas. It is also called Yellow Bark and Quercitron Oak (*Quercus velutina*). The wood is very red, open grained and generally inferior to other red oaks. A tanning extract known as Quercitron, and largely used, is made from the bark. The inner bark yields a yellow dye.

Pin Oak grows from New York to Virginia and is common west of the Alleghany Mountains, to Wisconsin and Arkansas. It is also called Swamp Spanish Oak (*Quercus palustris*). The wood is inferior to white oak, but is sometimes sold for it.

Willow Oak grows near the coast from New York to Texas and from Kentucky to Arkansas. It is also known as Peach Oak (*Quercus phellos*).

OLD WORLD OAKS

Old World Oaks yield wood very similar to that of the American species.

English Oak is common throughout Europe, Syria and northern Africa. It is known as European and Durmast Oak (*Quercus robur*).

Turkey Oak of middle and southern Europe and western Asia is also known as Adriatic, Iron, and Wainscot Oak (*Quercus cerris*).

There are several species of important timber oaks in India (the Himalayan region) and several in Japan. Many of these trees are evergreen and belong to the live oaks.

CORK

In one European species of oak (*Quercus suber*) the bark is unusually thick and spongy, and the outer layer can be stripped off without injury to the tree. The product of the first stripping, called virgin cork, is rough. It is used chiefly for tanning and for decorative purposes by florists. In from six to ten years another layer can be removed. The best cork comes from old trees. It is taken off in large sheets, dipped in hot water, pressed flat, dried, and baled for shipment. Corks are cut by machinery and the cuttings and waste are used in making linoleum and life preservers. Cork is produced principally in Portugal, Algeria, Spain, southern France, Tunis, Italy, Morocco, Greece and Austria.

ASH

Ash is a wood of great value because of its strength, elasticity and comparative lightness. It is easy to work and its many excellent qualities cause it to be used for agricultural implements, carriages, buggy shafts, oars, fishing rods, etc. It is also employed for furniture, interior of cars, boat cabins and building. There are several species, of which the most important is the first named.

White Ash grows throughout the eastern and central United States, from southeastern Canada to Minnesota and Texas. The trees (*Fraxinus americana*) are from 50 to 125 ft. high with trunk diameters of 4 to 6 ft.

Oregon Ash grows from Washington to California along the coast.

Red Ash, Green Ash, Black Ash, and Blue Ash are all small or medium sized trees growing in the eastern or central United States.

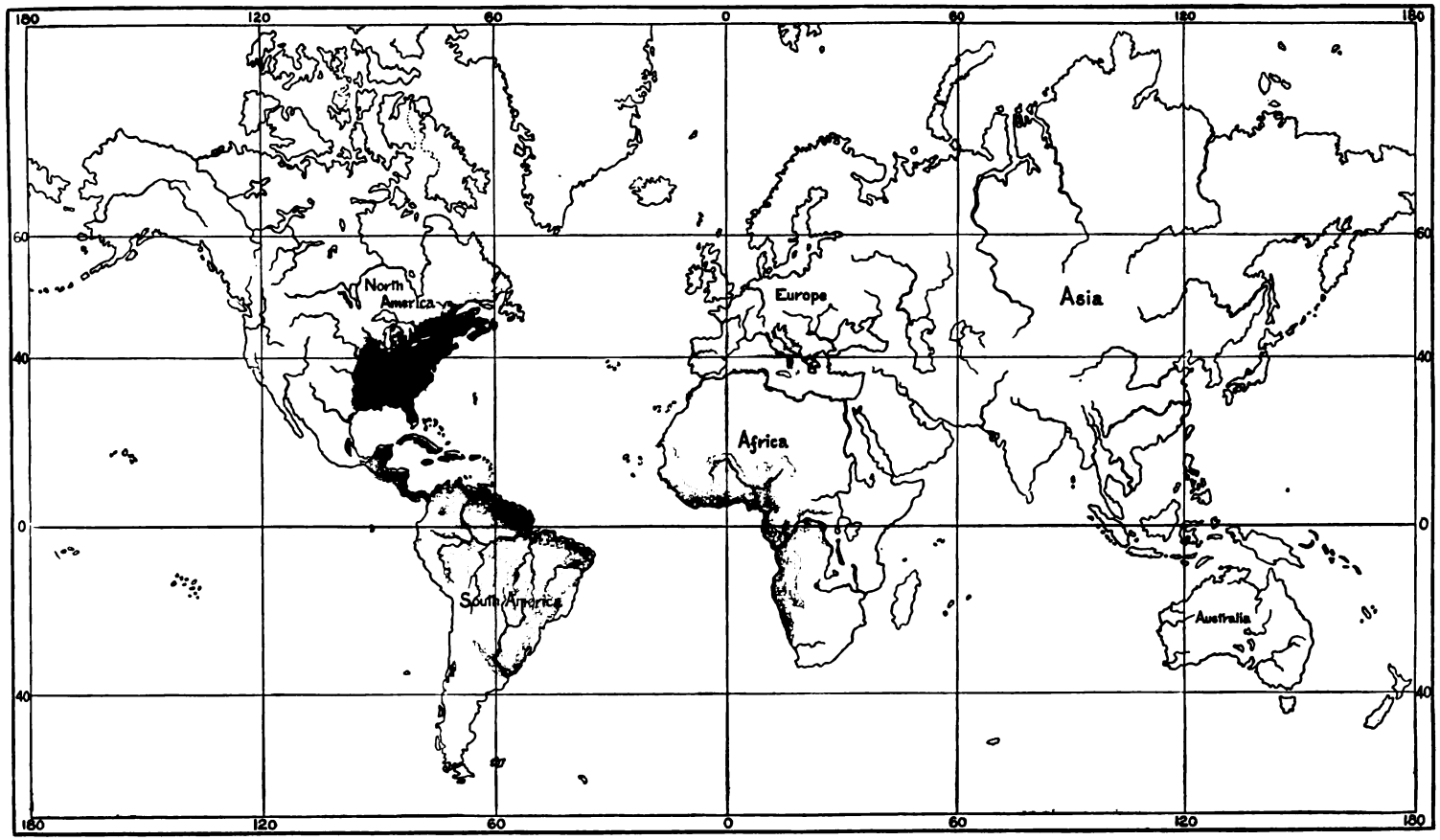
European Ash is a native of all Europe and north Africa. It is also called Common Ash. Curly forms of the wood occur in Hungary that are much prized for furniture and are imported to the United States.

Shioyi-Noki, the common ash of Japan, is similar to our smaller ashes and is used similarly.

CHESTNUT

Chestnut is included among the so-called hard woods, although it is soft, light, not strong, and is easily split and worked. Formerly little used except for fencing and rough construction, it has now become one of the most commonly used cabinet woods. It is open grained, very decorative because of the wide annual rings, light brown in color and has much the appearance of, and is often used as a substitute for, plain sawed oak in furniture and interior finish. It is very durable. The young trees are extensively cut for telegraph poles. The wood is also used for making charcoal and a tanning extract is made from the wood and bark. The nuts are an important article of commerce.

American Chestnut is common throughout the northern United States from Maine to Tennessee. The trees (*Castanea dentata*) grow to a height of 100 ft. and the trunks 4 to 12 ft. in diameter.



GEOGRAPHIC DISTRIBUTION OF

RED OAKS
SUGAR MAPLE
HICKORY
WALNUT

WHITE ELM
CHERRY
SYCAMORE
ASH

MAHOGANY
SWIETENIA (AM.)
KHAYA (AFRICA)

CORK OAK

European Chestnut is very similar, the trees often reaching an enormous girth.

ELM

Elm is, for special uses, a very desirable wood. It is similar to ash, but tougher, stronger, equally elastic and even easier to work. The grain is similar to ash, but the texture is velvety and the color grayish. It is used for boat-building, wagon spokes, extensively for fellies, the rims of metal wheels, for agricultural implements, butcher blocks, carriages, tool handles, cooperage, flooring, etc.

American Elm grows from southern Newfoundland to the Canadian Rockies, south to Florida and northern Texas. It is also called White Elm. (*Ulmus americana*). The trees grow 100 ft. high with trunks from 4 to 7 ft. in diameter.

Rock Elm is found from Vermont and Ontario to Kentucky and Iowa. It is also called Cork Elm (*Ulmus racemosa*).

Red or Slippery Elm, Cedar Elm, and Winged Elm or Wahoo are smaller trees of the central and southern United States, the former as far north as Ontario.

English Elm grows throughout Europe. The wood is similar to American Elm.

HICKORY

Hickory is justly famous as one of the toughest of woods and is, therefore, much used for purposes where strength is necessary. It is very tough and pliable when green, but after thoroughly drying becomes stiff and somewhat brittle. It is supposed to excel for wagon axles, spokes, fellies, axe, pick and hammer handles, certain agricultural implements, etc. The white sapwood, though generally preferred, is not superior to the darker heartwood. The trees grow from 80 to 100 ft. high and with trunks from 3 to 4 ft. in diameter. The woods of the several species do not differ. The species grow from southern Ontario to Minnesota, Florida and Texas.

Shell bark Hickory is also called Shag Bark (*Hicoria ovata*). The sweet, thin shelled nuts are an article of commerce.

Mockernut Hickory is also known as King Nut, Bull Nut and White Heart Hickory (*Hicoria alba*).

Pignut Hickory is called Brown and Black Hickory (*Hicoria glabra*).

Pecan (*Hicoria pecan*) is common from Indiana to Nebraska, and to southern Texas. The wood is somewhat inferior to shell bark hickory; the nut superior to all other species.

LOCUST

Locust is useful for fence posts, railroad ties, sills, etc., because of its great durability in contact with the soil. The Common Locust (*Robinia pseudacacia*) with yellow wood and the Honey Locust (*Gleditschia triacanthos*) with brownish red wood, both medium sized trees, are common in the eastern central United States.

The dark colored distinctly decorative woods native to the United States, are used almost exclusively for purposes where beauty of color and grain are essential.

BLACK WALNUT Black Walnut grows from Massachusetts to Florida, and from Minnesota to central Texas. It was formerly so sought after as a favorite cabinet wood that it has become very scarce. It is now principally used for gun stocks, turnery, mouldings, inlay work and musical instruments. The trees (*Juglans nigra*) occur from 100 to 150 ft. high with trunks from 6 to 10 ft. in diameter. The wood is very dark brown or purplish brown moderately hard and strong but easily worked. The nuts are edible.

Old World Walnut is a native of China and Persia and has been extensively introduced throughout Europe, and is commonly known as English, French and Italian Walnut. The wood is used for gun stocks, cabinet work, veneering, etc.

BUTTERNUT Butternut (*Juglans cinerea*) is similar to walnut, but softer and of a light pinkish brown color. It grows from southern Canada and Minnesota to Mississippi and Arkansas. The nuts are edible.

CHERRY Cherry has now become exceedingly scarce and high priced. Few woods possess its combined advantages of color, grain, texture and stability, these making it prized for pattern making, turning, printer's furniture, musical instruments, cabinet work, veneers, electrical instrument bases and interior finish. The tree that furnishes cherry lumber is Wild Black Cherry (*Prunus serotina*), growing from Ontario to Florida and from Dakota to Texas. It grows commonly as a shrub and as a tree from 30 to 100 ft. high with a trunk from 6 inches to 4 ft. in diameter. The wood is light reddish brown, turning darker with age. The common deep red color is given it by stain.

SWEET GUM Sweet Gum is a tree now of great economic value, the wood being used for cabinet work, interior finish, fancy boxes, log turned basket and box veneers, cooperage and to some extent for building. The tree is common from New Jersey to Florida and from Missouri to southern Mexico. It is also called Bibsted, Red Gum and Hazel (*Liquidambar styraciflua*). The trees grow from 100 to 150 ft. high with a diameter of trunk from 4 to 6 ft. The wood is not heavy nor hard, and is of a light brown color.

OREGON ALDER Oregon Alder is a tree of the Pacific Coast, from Alaska to California. The wood is extensively used for cabinet work, carriage bodies and interior finish (*Alnus oregana*). The wood is light reddish brown, hard and durable.

Imported Woods are almost all from tropical countries. They are generally valuable because of their beauty of color and grain.

MAHOGANY Mahogany is preferred to most other woods for cabinet work, and for a great variety of purposes. It is generally easily worked, and is often of a beautiful color and figure. It is used for musical instruments, fine furniture, the best interior finish in houses, cars and the cabins of ships, for turnery, tool handles, inlaying, parquetry

floors, electrical instruments, cameras and jewel boxes. The deep red color of mahogany seen in piano cases, etc., is given it by stain. This is still deepened by the wood becoming darker with age.

American Mahogany is the common mahogany and grows in the West Indies, Central and northern South America. The best comes from Tabasco in Mexico and from Santo Domingo; very good from Yucatan, Cuba, etc., and inferior kinds from Honduras and further south. It is also called Bay Wood and Caoba (*Swietenia mahogoni*). The trees grow 50 to 150 ft. high, with trunks 1 to 4 ft. in diameter. The wood varies from pinkish white to reddish brown, and from moderately soft to hard.

African Mahogany grows throughout the tropical west coast and inland. It is called Khaya (*Khaya senegalensis*). The wood is yellowish brown, hard, heavy and strong and often beautifully figured. It is largely imported into Europe.

CIGAR-BOX CEDAR

Cigar-Box Cedar is perhaps the most common and useful wood of the West Indies, Central America and northern South America. It is used for all kinds of general construction, for boats, boxes, building, cheap and fine furniture, cooperage, and is largely exported to the United States and Europe for cigar boxes and for furniture. Much of the so-called mahogany furniture at this time is made of selected dark "Cedro" often figured, though it may be distinguished by the larger pits in the grain. It is also known as West Indian Cedar (*Cedrela odorata*). The wood is light, soft, very easily worked, colored from light yellowish to brown, and is very fragrant.

There are several species of so-called mahogany in Australia, the woods of which are dark red, often figured, hard, strong and durable, and they are extensively used locally and exported. The most important of these are as follows:

Jarrah (*Eucalyptus marginata*) grows in southwestern Australia.

Swamp Mahogany grows in New South Wales and is also called Red Mahogany (*Eucalyptus robusta*).

Forest Mahogany is found in eastern Australia and is also known as Red and Gray Gum and Hickory (*Eucalyptus resinifera*).

Moulmein Cedar is closely allied to true mahogany. The wood is very similar, but softer and generally darker red. It has a great variety of uses and is exported largely. It is a native of India, Java, the Philippines and Australia. In India it is also called Chitagong Wood and Indian Mahogany and in Australia, Red and Pencil Cedar (*Cedrela toona*).

TEAK

Teak is one of the most valuable of all woods. It is native in India, Burma, Siam, the Malayan Islands and the Philippines, and is extensively exported to Europe and occasionally to the United States. It is the best timber for ship building and for backing of armor plates, since it does not, like oak, corrode the iron. It is used for piling and wharfage, and is also largely used for railroad cars, flooring, gun stocks and furniture. The trees (*Tectona grandis*) grow 80 to 100 ft. high

with trunks 2 to 4 ft. in diameter. The wood is light brown, open grained, easily worked, somewhat oily and fragrant, and very durable.

Certain fancy woods, valuable entirely because of their beauty of color and grain, are brought into the United States and Europe and used for musical instruments, inlay work, brush backs, jewel boxes, knife and other handles, turnery and sometimes for fine furniture.

EBONY Ebony is found in tropical countries throughout the world, the blackest coming from Cuba, but now nearly exhausted, the most common, from the Gaboon coast, West Africa, and very excellent from Madagascar, the Philippines, Bombay, Ceylon and Siam. It is for the most part a medium sized tree with broad white sapwood. The black heart comes into market in small logs. There are several species (*Diospyros*, etc.).

ROSEWOOD Rosewood or Jacaranda grows in South America and is supposed to come from several trees (species of *Dalbergia* and *Machaerium*). The wood is bright brown with black grain. A commercial rose oil is distilled from it.

Other fancy woods are: Cocobolo, from Central America, bright red and black; Granadillo, a similar wood; Tulip wood, from Brazil, red and yellow; Amaranth, or Purple Heart, from South America, deep purple on exposure to light; Padauk, called also Vermillion, Redwood and Indian Mahogany, from China, Burma, Malaysian Islands and the Philippines; Indian Satin wood from India and Ceylon, deep yellow; Prima Vera, called also White Mahogany, from Mexico and Central America, light yellow; and Olive wood, of the Mediterranean countries, from which tree also comes the olive fruit, an extensive article of commerce, used as a table delicacy, and supplying olive oil.

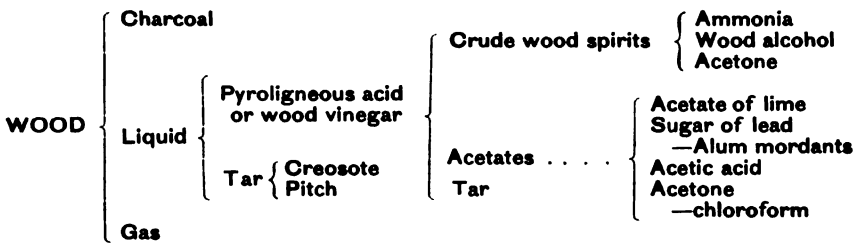
Other tropical woods are imported because they are suited by color, hardness and strength for many special purposes. These are: Rule Boxwood, from the West Indies and South America, the bright yellow wood used for rules, handles and inlaying; Lignum Vitae, from the West Indies, the hard, oily, greenish-brown heart and yellow sapwood used for pulley blocks, bearings, tool handles and caster wheels; Green-heart, from South and Central America and the West Indies, used for handles, brush backs and fishing rods, and Lancewood, from Jamacia, used for bows and fishing rods.

There are certain Australian woods used for general purposes of construction besides those already mentioned. Red Gum is from eastern Australia and the Murray River. The wood is hard, tough, strong and deep red, and is used for heavy construction. Allied to it are several other species of so-called gum, ironbark, tallow wood, etc., all belonging to Eucalyptus species. From the leaves of most of these trees Eucalyptus oil is or may be extracted for medicinal use. Other woods are: Honey-suckle, from southern Australia, prized for decoration and appearing much like Sycamore of the United States; so-called Oak, which is not an oak;

Blackwood, which is similar to Walnut; Black Bean and White Cedar, allied to Mahogany.

DISTILLATION OF WOOD

When wood is heated in a retort, various gases are driven off. Some of these gases, when passed through cooled pipes, become condensed into a liquid, and charcoal is left in the retort. This process is called distillation. By re-distillation and treatment with certain chemicals, the liquid may be made to yield a variety of useful substances as is shown in the accompanying diagram. Oak, maple, birch, beech and pine are the kinds usually distilled.



Uses of Products.

Charcoal—Fuel, filtering, gunpowder, etc.

Gas—Fuel, illuminant.

Ammonia—Medicine, household uses, chemical manufacture.

Wood alcohol—Denaturing alcohol, aniline color making, varnishes, burning, methylated ether, formaldehyde, etc.

Acetate of Lime—Dyeing, calico printing.

Mordants—Dyeing.

Acetates—Calico printing.

Acetic Acid—Chemical manufacture. So-called "Banana Oil," a derivative from acetic acid, is used in varnishes and paints.

Acetone—Chloroform, iodoform, sulphonal, smokeless powder.

Chloroform—Anaesthetic, solvent for resins, etc.

Creosote—Antiseptic, medicine, preservative.

Tar—Protection of wood against decay; tar paper.

Pitch—Shipbuilding, roofing, etc.

For smoking meats and fish, beech, oak and mahogany are chiefly used.

Potash is obtained by dissolving it out of wood ashes, formerly almost the only source of this important chemical. Potash is now prepared by chemical processes from various materials. (See Potash salts.)

Vegetable matters, such as sawdust, straw or bran, when heated with caustic potash, form oxalates, which on treatment with sulphuric acid, yield oxalic acid. This acid and its salts are used chiefly in bleaching and dyeing.

GUMS AND RESINS.

Gums and resins are usually formed by the drying of sap on reaching the air through fissures or incisions in the bark, or by the transformation of plant tissues. Some are obtained by artificial drying or distillation of sap. Many resinous extracts are taken from barks, woods, or other parts of plants, usually by dissolving the soluble matter in water.

True gums form a mucilage with water and are insoluble in alcohol. They are chiefly used in stiffening silk and cotton fabrics, in calico printing, in making cordials and confectionery, in mucilage, printing ink, and medicines. Many other substances are commonly called gums, such as resins, copals, rubber, camphor, lac, etc.

Resins are harder than gums, insoluble in water, and are mostly used in making varnishes by dissolving them in turpentine and linseed oil or in spirits. Gum-resins are usually fragrant and are used for medicines and as incense. Oleo-resins and balsams, like crude turpentine, lacquer and Peruvian balsam, are thick liquids generally obtained by tapping trees and preparing the sap.

GUM ARABIC Gum Arabic is obtained from small thorny trees (*Acacia* species) which grow in dry sandy districts in Arabia, Egypt, Kordofan, and the adjacent country. Gum senegal is of somewhat inferior quality and comes from similar trees in northwest Africa in the region of the Senegal river. Gums, like gum arabic, are obtained from acacia trees in other countries, for example, Morocco or Barbary gum, Cape gum from South Africa, and Wattle gum from Australia. These gums, like most others, are sorted over according to size, color, and purity and come on the market in different grades.

Dextrine is an artificial gum. (See Dextrine.)

GUM TRAGACANTH Gum Tragacanth comes from the stems of low thorny shrubs (*Astragalus* species) which grow in Asia Minor, Persia, Syria, and Armenia. The secretion of this gum is often increased by the natives through injuring the bark. It is found on the market usually as "flake tragacanth" in thin flat pieces, dull white in color, and marked with wavy lines which show the successive flow of the gum from the tree.

Gums are obtained also from the mesquite tree (*Prosopis* species), in Mexico, and occasionally from cherry, peach, plum, and other fruit trees.

GELATINE Gelatine, having much the same composition and properties as gum and used for similar purposes, is obtained by boiling certain sea weeds. The most important sea-weed gelatine, "agar agar," comes from China, Japan, India, and the neighboring islands. Irish moss, or dulce, is a gelatinous sea weed used for food.

Other similar mucilaginous substances, gelatines, and glues, are made from bones, horns, and slaughter house wastes. (See Animal Products.)

Copals are natural hard resins which are found in various parts of the world and are used in making varnishes. They usually have to be melted or

distilled to make them soluble in turpentine or alcohol. Many copals are found in the earth, usually at a depth of not more than a few feet, in places where extensive forests once grew.

ZANZIBAR COPAL

Zanzibar Copal is the hardest of this group. It is found along the Zanzibar coast, in Mozambique. Some comes from living trees (*Trachylobium* species), but the hardest and best is the fossil variety which is dug from the ground. When first dug, the resin is covered with a sandy reddish crust, which is either scraped off, or dissolved away by a solution of soda or potash, leaving the copal with a facetted surface, called the "goose-skin." This is characteristic of the best grades of Zanzibar copal. Factories for the cleaning and washing of copal were formerly situated at Salem, Mass., so that this grade is often called Salem copal. Sandarusi copal, Mozambique copal, Sierra Leone copal or Flint copal, West African copal, Benguela copal, Angola gum, Muccocota gum, Loango gum, American copal, Anime, Courbaril copal, Accra copal, and Manila copal are names applied to similar resins of varying hardness from different localities.

KAURI COPAL

Kauri Copal, or gum, is softer than Zanzibar copal. It is obtained in New Zealand and New Caledonia, some of it from living trees (*Agathis* species); but a much larger quantity is dug from the ground, where it occurs at a depth of from a few inches to ten feet. The lumps are usually only an inch or two in diameter, but some have been found weighing a hundred pounds. The tree which yields this resin belongs to the pine family and attains a height of 80 to 100 feet and a diameter of 3 to 8 feet or more. The timber resembles yellow pine and in New Zealand is used for many purposes.

GUM DAMMAR

Gum Dammar includes commercially several kinds of resins from southeastern Asia. The true dammar comes from a tree (*Shorea* species) in Sumatra. Mixed with turpentine it makes a very clear and valuable varnish.

Sandarack resin from northwest Africa, and **Mastic** from the shores of the Mediterranean, are similar in nature and are also used in varnishes.

Benzoin is a fragrant resin from Siam, Java and Sumatra, used chiefly for incense.

Asafœtida is a gum-resin obtained in Afghanistan from the roots of a plant (*Scorodosma fœtidum*). It is much used in medicines and as a condiment, especially in Worcestershire sauce.

Myrrh and **Olibanum**, or frankincense, are fragrant gum-resins from Arabia used for incense and in medicine.

Gum ammoniacum is a gum-resin used in medicine.

Aloes is the dried juice of certain plants (*Aloë* species) used in medicine.

Guiac or gum guaiacum is a medicinal resin from the lignum vitæ tree.

Dragon's blood is a red resin used in medicine and for varnish.

Kino is a dried juice used in tanning and dyeing.

(See Quebracho extract and other substances used in tanning and dyeing. See Lac, Shellac, Turpentine, Rosin, etc.)

Japanese lacquer is obtained from the sap of a small tree (*Rhus vernicifera*), the berries of which furnish wax. Varnishes having similar qualities are manufactured by mixing turpentine with various resins.

Peru balsam, tolu balsam, copaiba balsam, and liquid storax are all obtained from the saps of certain trees and are chiefly used in medicine.

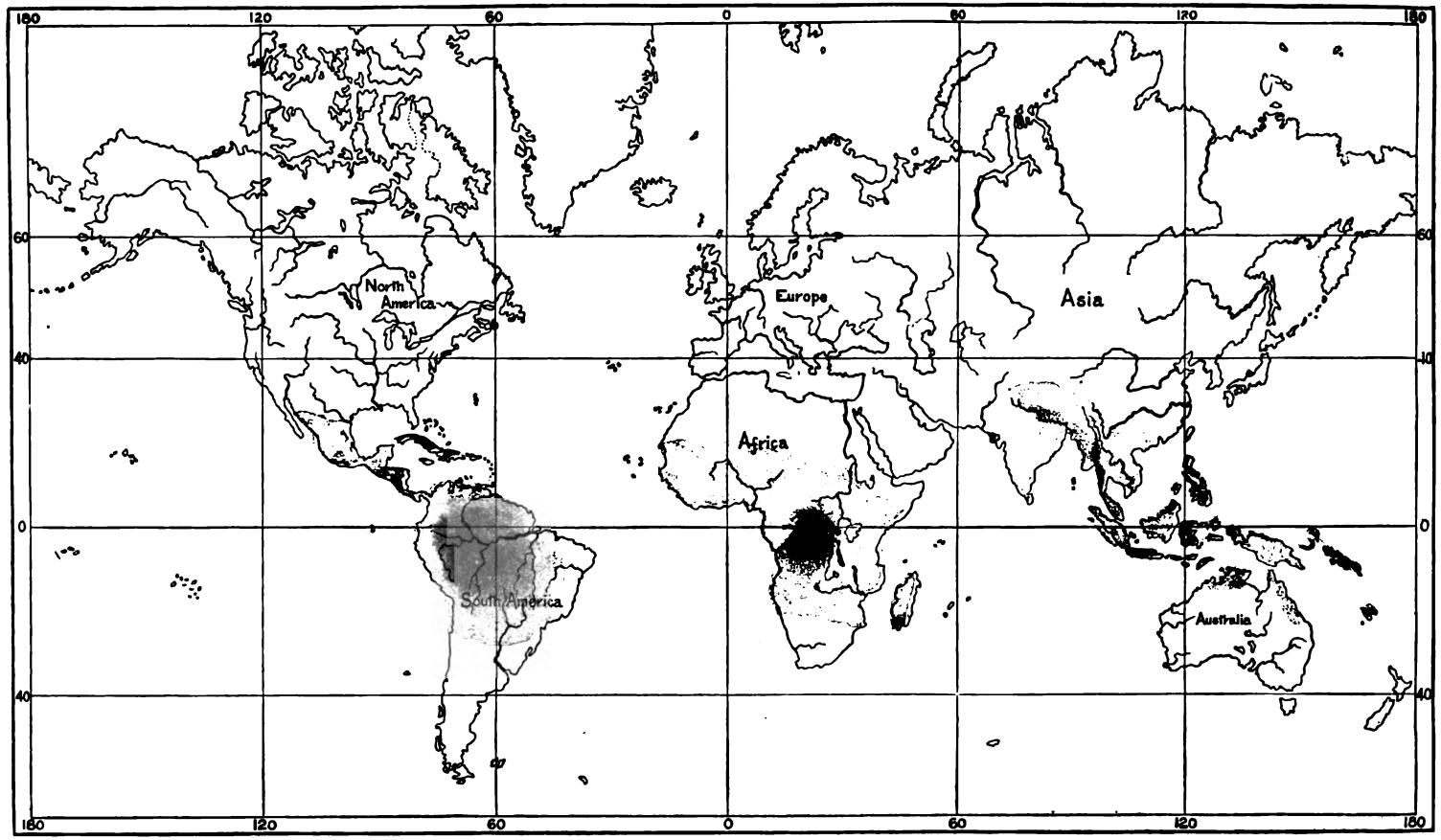
Gamboge or "gummi gutti" is obtained in Cambodia by tapping trees (*Garcinia morella*) and collecting the yellow sap in joints of bamboo, where it hardens. It is used in medicine and in coloring varnishes and making water colors.

RUBBER

Rubber is an elastic substance produced from the milky juice of certain trees and vines which grow in tropical regions. More than half of the world's supply of rubber comes from the valley of the Amazon river. Africa, the East Indies, Mexico, and Central America are the other chief sources.

The most important rubber plants are the Brazilian or Para rubber tree (*Hevea brasiliensis*), the Central American rubber tree (*Castilloa elastica*), the East Indian rubber tree (*Ficus elastica*) and the rubber vines of Africa (*Landolphia* species).

"Rubber milk" is usually obtained by making incisions in the bark and catching the milky juice or "latex" in small cups as it flows out. It resembles cream in density and appearance and is composed essentially of globules of rubber floating in water. The globules are coagulated by processes which differ in various places. In Brazil the finest grade Para rubber is prepared by pouring the latex on a stick or paddle and drying it over a smoky fire. As soon as the layer of rubber is dry, more milk is poured on, and another layer formed, until the lump of rubber weighs several pounds. In other places the milk is allowed to dry on the trees or is coagulated by boiling, or by adding alcohol, sulphuric acid, lemon juice, or salt water, or in one of many other ways. Rubber is graded commercially according to the country or district of origin and according to its quality. In the crude state it usually contains much dirt, sand, gravel, bark, etc. For use it must be cleaned by softening, grinding, and washing. It is too soft and sticky for most purposes when pure, and is, therefore, mixed or compounded with various materials. When combined with a small per cent. of sulphur with the assistance of heat, it becomes "vulcanized" and is more elastic, less soluble, and will stand more heat or cold without becoming sticky or brittle, than pure rubber. Red rubber is vulcanized by heating the crude material with a sulphide of antimony. Lamp black is added in making black rubber. Hard rubber, ebonite, or vulcanite, is prepared by vulcanizing rubber with as much as 25 per cent. of sulphur, making it hard and horny. Substitutes and adulterants for rubber are made by heating oils, such as cotton, linseed, rape, corn, or castor oil with sulphur. Rubber enters into the manufacture of almost innumerable substances, among which the following may be mentioned: soft or vulcanized rubber-bands, threads for



GEOGRAPHIC DISTRIBUTION OF

RUBBER

elastic cloth, toys, shoes, boots, tires, tubing, hose, cushions, water proof cloth, printing rolls, stamps, stoppers, etc.; of hard rubber: combs, brushes, handles, electrical instruments and other machinery, surgical and toilet appliances, buttons, trays, and vessels for holding corrosive chemicals. Rubber is used in grinding-wheels as a cement to hold the particles of the abrasive together, in floor cloths, cements, and some varnishes.

GUTTA-PERCHA Gutta-Percha is a plant product similar to rubber. It is obtained from the milky juice of a number of trees belonging to the Sapota family (*Sapotaceae*), found in the East Indies, the Malay peninsula and some other tropical countries. The principal port of shipment of crude gutta-percha is Singapore. The gutta-percha is usually obtained by cutting down the trees, removing narrow strips of the bark and collecting the milky juice that flows from the wounds. It soon thickens and hardens. It is then put into a pot of boiling water and becomes so soft that it can be kneaded and pressed into a compact mass. The crude commercial material is purified by grinding in hot water, by which the chips, bark, and sand are removed. The plastic mass is then rolled into thin sheets or formed into threads and rolled into balls and pressed. At the ordinary temperature gutta-percha is compact, pliant, tough, and but slightly elastic. At 194° F. it becomes plastic, so that it can be kneaded and brought into any desired shape, which it retains unaltered when brought back to the ordinary temperature. It is not nearly so sensitive to cold as rubber, a temperature of 14° F. not altering it.

No other plastic substance has so great an electrical resistance, and in the ground or in the water gutta-percha retains this property unaltered. It is this property that gives gutta-percha its most important use—as an insulating material for electrical wires, especially for submarine and underground cables.

Gutta-percha is especially useful for articles exposed to moisture, damp, cold, and acids, and for that reason is employed in the form of hose for conducting cold water, beer, wine, and acids; for belts running in wet places; for buckets, ladles, bottles, siphons, and spigots in chemical factories.

Balata is very similar to gutta-percha and comes from Guiana. Gutta joolatong, another substance of the same kind, has come on the market within a few years and is obtained in the East Indies.

CHICLE Chicle or crude chewing gum is obtained by boiling the milky juice of a tree (*Achras sapota*) which grows in Mexico and Central America. Yucatan produces nearly the entire supply of chicle, and exports all of it to the United States. For the preparation of chewing gum the chicle is dried, washed, mixed with glucose, paraffine, or other materials, flavored, rolled out into thin sheets, and put up in small packages for sale.

Many other plants, such as our common milkweed, produce milky saps which when dried yield substances more or less like rubber or gutta-percha. The juice of the cow tree when fresh is much like cow's milk.

OILS, FATS AND WAXES.

The seeds and fruits of many plants are rich in oil, this being the concentrated form in which nutriment is stored for the early growth of the young plant. Nearly all animals possess fats capable of being rendered into oil and usually stored in the abdominal cavity or in a layer under the skin. These oils are called fatty oils and differ from petroleum or other mineral oils and from essential oils in the fact that they may be saponified.

Vegetable oils are obtained by crushing the seeds by powerful machinery, thus pressing out the oil and leaving oil cake behind. They are sometimes extracted by dissolving in carbon bisulphide or other chemicals.

Oils are used for table purposes, for cooking, soap making, lubricating, illuminating, mixing paints and varnishes, in dyeing, in preparing skins and leathers, in medicine, and for other purposes.

Oils are of two important kinds, drying oils, which, like linseed, evaporate and oxidize, forming a varnish-like substance, and non-drying oils, like olive oil. Some oils (fats) like palm oil, Japan wax, and tallow are solid at ordinary temperatures. For lubricating purposes some non-drying oils are "blown" by passing air through the heated oil, rendering it thicker and more viscous.

In soap making, a fatty oil is heated and there is added to it a weak solution of alkali, such as caustic soda (lye) or caustic potash, which unites chemically with the oil, forming soap and glycerine. Soap being insoluble in brine, salt is then added and the soap rises to the top of the kettle, while the brine with the glycerine is drawn off from below. The soap is then purified and usually mixed with coloring and scenting ingredients. Mineral matters, such as sand and pumice, are added in making scouring soaps. Rosin can also be saponified and is much used with oils in soap making, as are also certain waxes. Candles are made from natural solid fats and waxes, and from prepared oils by a process similar to soap making.

GLYCERINE Glycerine is obtained as a by-product in the manufacture of soaps and candles. It is used in pharmacy, in various industrial processes, and very largely in the manufacture of nitro-glycerine and dynamite.

OLIVE OIL Olive Oil comes from countries bordering the Mediterranean and in small amount from Mexico and southern California. It is obtained by pressing the fruit of the olive tree (*Olea europæa*). Ripe olives, containing from 30 to 50 per cent. of oil, are first pressed lightly, yielding a small amount of the best quality oil. Crushing the flesh with greater pressure yields more oil, and a third pressure of the pressed cake after treatment with hot water, yields an oil of poorer quality. Olive oil is used for food, for soap making, lubricating, and burning. It is frequently adulterated with other oils such as cotton seed, peanut, sesame, etc.

CASTOR OIL Castor Oil is obtained from the seeds of a plant (*Ricinus communis*) which grows throughout tropical countries. India produces the most seeds for commerce. The seeds contain more than half their weight of oil, which is used in medicine, in the

manufacture of celluloid, oilcloth, artificial leather, for soap making and lubricating. Perhaps the largest amount of castor oil is used in the manufacture of textiles, especially for making "turkey red oil," which is employed for preparing cotton goods for dyeing with coal tar colors.

TURKEY RED OIL Turkey Red Oil is prepared by treating castor oil with sulphuric acid. It is unlike the original oil in being soluble in, or mixing readily with water. Olive oil or cotton oil is often used instead of castor oil. Fabrics treated with turkey red oil can be dyed with certain colors by which they are unaffected before such treatment.

PEANUT OIL Peanut Oil is obtained from the common peanut (*Arachis hypogaea*). The nuts, or seeds, are raised extensively in West Africa and India and are pressed in France. The oil is used for soap making and as a substitute for olive oil. In making peanut butter the nuts are simply ground up, but not pressed.

PALM OIL Palm Oil comes from West Africa and is obtained from the pulp which covers the seeds of the oil palm (*Elaeis guineensis*). It is yellowish or reddish in color, of the consistency of butter, and is used for making soap and candles, and for coating sheet iron in the manufacture of tin-plate. Palm kernel oil is pressed from the kernels of the same fruits.

Almond oil, rape oil, sesame oil, walnut oil, poppy seed oil, sunflower oil, soy bean oil, and vegetable tallow are a few of the great number of other vegetable oils.

(See Corn oil, Cotton oil, Linseed oil, Hemp oil, Cocoanut oil, Cocoa butter. See also Animal oils and Petroleum.)

ESSENTIAL OILS.

Essential Oils, or volatile oils, unlike the fatty oils do not form soap on treatment with alkalis. They are obtained in small quantities from flowers, leaves, or other parts of plants usually by distillation with water. Some, like orange and lemon oil, are pressed from the rinds of fruits. Those from flowers are obtained by a process called enfleurage which consists in absorbing the perfume from the flowers in lard, beef fat or olive oil. The perfume is then extracted from the fat or "pomade" by solution in alcohol. Essential oils are mostly used in perfumery, for flavoring, and in medicine. The best known examples of this group are turpentine and camphor, but these are not popularly known as essential oils.

The following are important:—attar of roses, patchouli, oils of lavender, bergamot, bitter orange, violet, geranium, tuberose, bitter almonds, cedar, hemlock, spruce, wintergreen, mint, sassafras, birch, cloves, lemon, orange, peppermint, citronella, lemon grass, vetiver, anise, fennel, caraway, cumin, rosemary, thyme, coriander, wormwood, ylang-ylang, sandal wood, cinnamon, bay, etc.

Menthol, produced in Japan, is deposited in crystals on cooling oil of peppermint.

Witch-hazel extract, used medicinally, is obtained by distilling young twigs of witch hazel with dilute alcohol.

Musk and ambergris are animal substances used as perfumes.

Oil of mirbane and other perfumes are obtained from coal tar, and many of these are identical in composition and have the same odors as essential oils obtained directly from vegetable substances.

CAMPHOR

Camphor is strictly not a gum, but a solid volatile oil obtained from the wood of the camphor tree (*Cinnamomum camphora*). Formosa is the source of nearly all of the camphor of commerce, although a little is obtained from Japan, China, and Borneo. To obtain camphor, the wood of the tree is cut up into small chips which are distilled with water. The camphor is condensed and later purified. It is used in medicines, as a protection against insects, and to a very large extent in the manufacture of celluloid and of smokeless powder.

(See Napthaline or tar camphor.)

WAXES.

Under waxes may be grouped beeswax and all substances resembling it sufficiently to be used as substitutes for it. Cheap waxes are very commonly used to adulterate those of higher grade.

Sealing wax, shoemaker's wax, and grafting wax are prepared resinous substances.

(See Beeswax, Tallow, Spermaceti, and Paraffine.)

MYRTLEBERRY WAX

Myrtleberry or Bayberry Wax is found coating the fruits of several species of myrtle bushes (*Myrica*) indigenous to the United States, Central and South America, Cape Colony, etc. It is obtained by plunging the berries in hot water and skimming off the wax which rises to the surface. It has a greenish color and a pleasant balsamic odor. It is chiefly used in combination with beeswax for making candles.

JAPAN WAX

Japan Wax is a hard, wax-like fat obtained from the fruits of several species of *Rhus* found growing in Japan (particularly *Rhus succedanea* and *vernicifera*, the tree which yields Japanese lacquer). It is chiefly used for the manufacture of candles, wax matches, waxed paper, and as a furniture polish. In Japan it is used to give a polish to cotton cloths, for making dolls and models, as well as for lubricating and soap making.

Wax forms a coating on the leaves of several palms.

Carnauba Wax, which comes from the under side of the leaves of a palm in Brazil, is rapidly gaining in commercial importance.

Chinese Insect Wax, or pela wax, is secreted by an insect (*Coccus pela*) and deposited on twigs. It is used in China for candles, for polishing wood and leather, and as a sizing for paper and cotton goods.

DYESTUFFS.

Commercial dyes are either the extracts from animal or vegetable matter, or artificially manufactured chemical compounds, chiefly from coal tar. They are used for dyeing fibers, fabrics, woods, leather, and feathers. The great diversity of tints obtained in dyeing is the result of the combination of two or more substances with one another or with certain chemical reagents. To render colors permanent, the application of some chemical known as a mordant is usually required; but for some dyes no mordant is needed. Turkey red oil, alum, tannin, argols, and compounds of soda, tin, chromium, and iron are the common mordants. Most vegetable dyestuffs are handled commercially in the form of extracts made by treating the raw material with boiling water and evaporating the solution.

INDIGO Indigo is a blue dye obtained from the juice of the indigo plants (mostly *Indigofera* species) which grow in tropical countries. India, Ceylon, Java, and Central America are the chief producers. The freshly cut plants are soaked in water, which absorbs the juice, becoming greenish in color; on exposure to the air it turns blue, the indigo separates, falls to the bottom of the tank and is dried. For dyeing, indigo is usually acted on by some chemical such as soda or potash, which reduces it to a colorless substance known as "indigo white." This is more easily soluble than blue indigo, and the materials to be dyed are dipped in a solution of this substance. Upon exposing the fabrics to air, the indigo white changes again by oxidation to indigo blue. In printing calicos, indigo white is thickened with gum, dextrine, or starch.

"Bluing" for laundry use is frequently indigo.

The manufacture of artificial indigo from coal tar has made the growing of indigo unprofitable in the West Indies and northern South America, where large quantities were formerly produced.

MADDER Madder is a powder made from the dried roots of a plant (*Rubia tinctoria*) which is cultivated in southern Asia and central Europe. It furnishes a red dye used for cotton goods, which is of decreasing importance owing to the use of coal tar colors.

LOGWOOD Logwood or campeche is the dark red heartwood of a tree (*Haematoxylon campechianum*), which grows in Central America and the West Indies. Yucatan, Honduras, Hayti and Jamaica are the principal commercial sources.

The wood comes to market in logs from five to ten inches in diameter, from which the bark and sapwood have been removed. Logwood extract is made in the West Indies as well as in America and Europe. This reddish coloring matter has no affinity for fibers and requires the use of a mordant, the color obtained depending on the mordant used. It is largely employed for dyeing black, but gives also shades of blue, gray, and violet.

BRAZIL WOOD Brazil Wood, or Pernambuco Wood, comes from South and Central America. As in logwood the heartwood of the tree (*Caesalpinia*) is used, and the coloring matter is extracted with boiling water. It gives shades of red and violet, but does not alone produce fast colors.

FUSTIC Fustic, mora, or yellow wood, also known as old fustic, is the wood of another tree (*Chlorophora tinctoria*) and is obtained in the West Indies and tropical America. It is used in dyeing woolen goods, giving a bright yellow color.

Young fustic, sappan, cam, and other woods yield dyes.

Quercitron is the ground bark of the yellow-bark oak tree (*Quercus velutina*) of the United States. It yields a yellow dye and is also used in tanning.

SAFFLOWER Safflower consists of the dried flowers of an herb (*Carthamus tinctorius*) which is grown in many warm countries. Its production is important in India, Persia and Egypt. It is powdered and mixed with starch to make toilet rouge and its extract gives a red dye for silk.

ANNATTO Annatto furnishes a harmless yellow dye used chiefly in coloring butter and cheese. It is obtained from the pulp which surrounds the seeds of a shrub (*Bixa orellana*) cultivated in South and Central America and the West Indies. The pulp is washed from the seeds by water, separated and dried. It comes on the market as a red or orange colored liquid or paste and also in cakes. The dried seeds with pulp adhering are also exported.

Turmeric, turnsole, yellow berries or Persian berries, saffron, henna, orchilla, cudbear, and litmus are other vegetable dyestuffs from roots, seeds, flowers, and lichens.

See Cochineal, Lac, etc., under Insect Products.

See also Coal Tar colors, Prussian Blue, Chrome Yellow, etc., under Mineral Products.

TANNING MATERIALS.

Tans include all substances which by acting on the fiber of skins and hides render them proof against the ordinary process of decay and at the same time make them pliable. Most of the vegetable substances used to convert skins and hides into leather contain an astringent principle called tannin. Many other substances are used by tanners in preparing skins and leathers for market, such as lime for unhairing, acids, sodium salts, alum, dog's dung, bird's dung, bran, lampblack, oils, egg yolks, dyes, varnishes, etc. (See Tanning.)

Many substances, such as cutch and quercitron, are used both in tanning and in dyeing.

The following, or extracts made from them, are among the most important tans: *barks*—hemlock, oak, wattle, mangrove, larch, willow; *woods*—oak, chestnut, quebracho, gambir, cutch; *fruits*—myrobalans, valonia, divi-divi, algarobilla; *leaves*—sumac; *galls*—oak, sumac; *roots*—canaigre, palmetto.

TAN BARKS

Hemlock bark is the most important vegetable tanning material in the United States.

Both the wood and bark of the white oak tree are used in tanning and in making extracts. The wood of the chestnut tree, but not the bark, is also used.

Wattle bark is obtained from mimosa trees (*Acacia*) in Australia. It is exported to England as well as used locally. It is increasing in importance. These trees yield gums like gum arabic and furnish useful woods.

Mangrove bark is obtained from trees (*Rhizophora*) which grow on swampy coasts throughout the tropics. It is used in many places for tanning, but is seldom an article of general commerce.

LEAVES

Sumac leaves are obtained from different species of sumac (*Rhus*) in Mediterranean countries and in the southern United States. In general, the leaves from Europe are richer in tannin. Sumac is used for tanning fancy leathers.

EXTRACTS

Quebracho extract is obtained by boiling chips of a hard red wood (*Schinopsis*) which grows in Argentina and Paraguay. The extract is of increasing importance. The wood is too hard and heavy to be valuable for construction or cabinet work.

Cutch or catechu is extracted from the heartwood of an acacia tree common in India and Ceylon. It is used for dyeing and in tanning heavy leathers.

Gambier or terra japonica is a similar extract coming from India and obtained from the leaves of a bush (*Uncaria gambier*). It is used in tanning soft leather.

Valonia consists of the cups of acorns (*Quercus aegylops*) which grow in the Levant. They are rich in tannin.

Palmetto extract is made from the roots and creeping stems of the saw palmetto in the southern United States. (See Palmetto fiber.)

OAK GALLS

Oak Galls are the product of small insects allied to the wasps and belonging to the order *Hymenoptera*. These insects cause the hard woody abnormal growths upon the smaller branches and leaves of oak trees The female deposits an egg within the bark and the tiny larva, hatching, feeds on the soft wood. The insect is supposed to secrete a stimulating fluid which augments the growth and causes the gall to form. When the larva attains its growth it changes to the pupa and then to the perfect fly and cuts its way out of the gall. The commercial oak galls grow upon a tree (*Quercus luscitanica* var. *infectoria*) common in southwestern Asia. (The insect cause is *Cynips quercus tinctoriae.*) The best galls come from Syria and Asia Minor and are exported from Aleppo. Galls contain gallic acid, closely allied to tannic acid. They are used for tanning, and especially for making ink and dyes with salts of iron. There are other commercial and useful galls growing upon trees (*Rhus semialata*) in China and Japan. These are caused by plant lice (*Schlechtendalia chinensis*), insects belonging to the sub-order *Homoptera.*

Pyrogallic acid, a chemical derived from galls, is an important photographic developer.

MISCELLANEOUS SUBSTANCES.

ARGOLS Argols are deposited as a crystalline coating in casks of young wine. They are called lees, and consist of crude potassium acid tartrate ($C_4 H_5 O_6 K$). Argols are the only commercial source of tartaric acid and tartrates. These are useful as mordants in dyeing, and calico printing, in making baking powder, cream of tartar, Rochelle salts, Seidlitz powders, and tartar emetic.

VEGETABLE IVORY Vegetable Ivory nuts are the seeds of several species of palm trees. The kind most commonly used (*Phytelephas macrocarpa*) come from Ecuador and Panama. When fresh, they are soft, juicy, and edible; but on drying they become hard. On soaking in water they become soft enough to be cut with a knife. They are used for making buttons, chessmen, and small ornaments.

Lycopodium powder consists of the minute spores of certain species of club mosses common in Europe. It is used in making fireworks and by pharmacists.

Soap bark and **soap berries** are collected in various countries. The common soap bark sold at drug stores comes from Chili.

Teasels are the dried heads of a common plant and are grown in Europe for use in finishing woolen fabrics.

Pyrethrum, a substance used in insect powders, consists of the powdered flowers of plants allied to the chrysanthemum. It is obtained chiefly from Dalmatia, Persia and southeastern Europe.

There are many other vegetable materials in common use, some of which enter into general commerce.

ANIMAL PRODUCTS.

Animal Products may be conveniently classified as follows:

Live animals for beasts of burden, for slaughtering, for breeding, etc.

Articles of Animal Origin used for Food:—Meats, fresh, dried, salted, canned, or otherwise preserved, from cattle, sheep, swine, fowls, game, etc.; meat extracts, fish, oysters, crabs, lobsters, eggs, milk, butter, cheese, lard, oleomargarine, gelatine, etc.

Animal Fibers:—Hair, wool, fur, bristles, silk.

Hides and Skins:—Furs, raw hides, leathers, feathers.

Horns, Hoofs, etc., including ivory, tortoise shell, glue.

Animal Oils:—Butter, lard, cod liver oil, fish oil, etc.

Pearl and Mother of Pearl, Sponges, Corals.

Other Products, including perfumes, etc., Musk, civet.

Insect Products (other than silk), including honey, wax, cochineal, lac, galls.

In the following pages these are grouped according to the animals which produce them.

HORSES.

Horses are raised in almost all parts of the world, chiefly as beasts of burden. In the United States the greatest number of horses are raised in the south and west; some are exported for breeding, racing and draft purposes to England, Canada and Germany. Russia supplies nearly half the horses used in Europe.

Horse flesh is eaten in France, Germany and other countries.

Horse hide is used for making "cordovan" leather for shoes, saddles and razor strops. The part of the hide most used for leather is an oval piece about three feet long from the rump. This leather is exceptionally strong and more nearly waterproof than that from any other land animal. It is finished in tan, black and other colors.

Horse hair from manes and tails comes on the market from Russia, China, Argentina, Germany, and other countries. It is used for weaving in hair cloth, for making brushes, and for bows for musical instruments. When curled it is used for stuffing mattresses and furniture.

Fermented mare's milk, "koumiss," is imported from western Asia for medicinal purposes. A preparation of cow's milk is sold under the same name.

Mules and asses are more used than horses in many places.

CATTLE.

Cattle are raised in all parts of the world and are important everywhere in local commerce. The United States, Russia, India, Argentina, Germany, Austria-Hungary, France and Australia are the greatest cattle raising countries. The United States, Argentina and Australia are the greatest exporters.

Live cattle are shipped from one place to another chiefly to supply fresh meat to distant points. Breeds of cattle, as of other animals, differ in various countries. Certain breeds, such as the Jersey and Alderney, are most valuable for milk; others are better beef cattle. The humped cattle of India thrive well in tropical countries. The Carabao or water buffalo is the principal draft animal and beast of burden in many Pacific Islands. In India and China, cattle are chiefly valuable as draft animals. In many places, the hides and tallow are the main products of the cattle industry.

Milk, butter, cheese, buttermilk and condensed milk are valuable commercially in nearly all countries.

Sugar of milk is used medicinally and in silvering mirrors.

BEEF

Slaughtering and meat packing are important industries in the United States, Europe, Argentina and Australia. Chicago, Kansas City, St. Louis and Omaha are the most important centers in this country. The export of live cattle is less important than it was a few years ago, because so much meat is now shipped in refrigerator cars and in the cold storage compartments of steamships. In addition to the fresh meats shipped, large amounts are dried, salted, corned, smoked, canned, or otherwise preserved, or made into soups and extracts. The by-products of slaughtering are very numerous and it may be said that in the great slaughter houses no part of the animal is wasted.

Cow Hair. The long hair from the tails is used like horse hair. The short hair which covers the rest of the body is used for mixing in plaster, and making roofing felt.

Horns and hoofs of cattle are utilized in making combs, buttons, umbrella, knife and other handles and fancy articles, also in the chemical manufacture of cyanide of potash.

Bones are used in making buttons, combs, handles for tooth brushes, and other articles, often as a substitute for ivory. The waste from bone manufacture is burnt, forming bone charcoal or bone black, which is used in filters for oil and sugar, and in making blacking. The grease extracted from bones is used in soap and candle making. Some ammonia is recovered in burning bones.

Tallow is made from the fat or suet of cattle or sheep by melting and straining it, a process which is known as "rendering." It is used for soap and candle making, for lubricating, and in dressing skins and leathers. The purified oils and fats are used in fabricating butter substitutes, such as oleomargarine and butterine. These, like real butter, are usually colored with annatto.

Neat's Foot Oil is made by boiling the feet of cattle and skimming off the oil as it comes to the surface. It is a valuable lubricant.

Gelatine is made from the feet of cattle and from hide cuttings and sinews. Calf's foot jelly is made by boiling the feet. Hides are treated with lye and then boiled in water, dissolving the gelatine, which sets on cooling and is cut into sheets to dry.

Glue is similar to gelatine in nature, but is usually made from bones by softening them with hydrochloric acid and then steaming them. The glue and bone fat are drawn off from time to time and separated in settling tanks. Liquid glues are made by dissolving ordinary glue in weak acids.

Size is used in preparing paper and fabrics and is similar to glue and gelatine.

Dried Blood is used in purifying sugar, clarifying wines, in dyeing, and in fertilizers. The albumen of blood is employed in calico printing and as a mordant in dyeing.

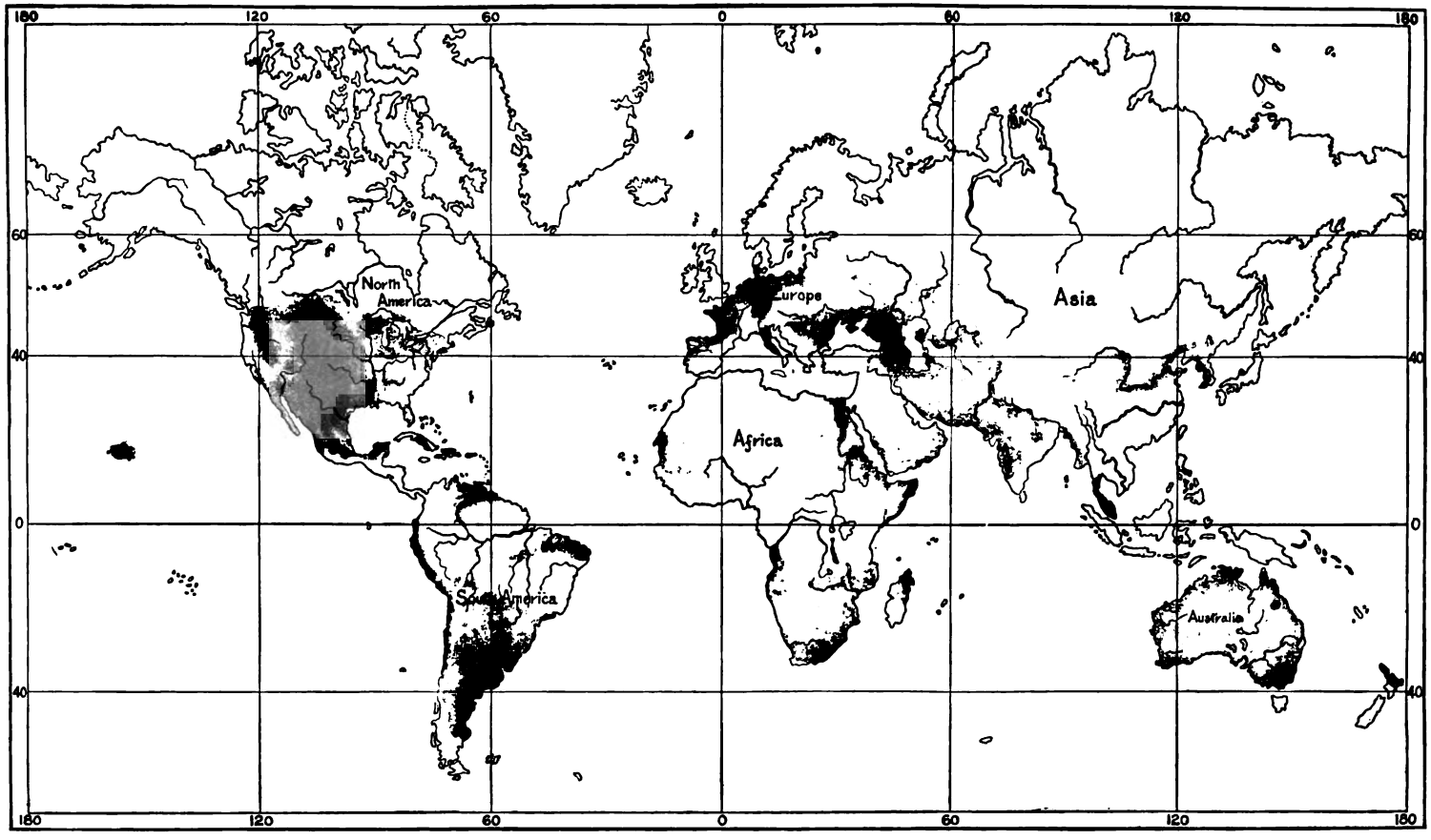
The Intestines of cattle supply goldbeater's skin, sausage skins, etc. Bladders cleaned and prepared, on account of their thinness and strength, are used by druggists and oil dealers as coverings for vessels.

Pepsin, rennet, and other substances are prepared from the lining of the stomach and certain other parts.

Fertilizers are made from all the waste and refuse parts of the animal, and from the cuttings and waste from bones, horns and hides.

Hides are known to the tanner according to the age of the animal, as "hides" from full grown cattle, "kips" from two year old animals and "calf skins."

Rawhide is simply the dried and cleaned skin from which the hair has been removed, softened by oils. It is used for ropes and lariats, for belts and belt lacings, whips, and faces for mallets.



COMMERCIAL SOURCES OF CATTLE HIDES

Vellum is made from calf skin by unhairing with lime and then rubbing it down with chalk and pumice.

TANNING.

When hides are received at the factory, they are either fresh from the animal (called "green" hides) or dried. The dried hides have usually been salted to preserve them from decay and must be soaked in water to soften them and dissolve the salt. After soaking, the hides are "fleshed" by being scraped with a knife and thoroughly scrubbed to remove all blood, fat and dirt. The hair is then softened either by soaking the hides in lime water or by a process of "sweating" which is equivalent to a very slight decay. In either case the hair is removed, generally by a machine, and the hides are then ready to be tanned.

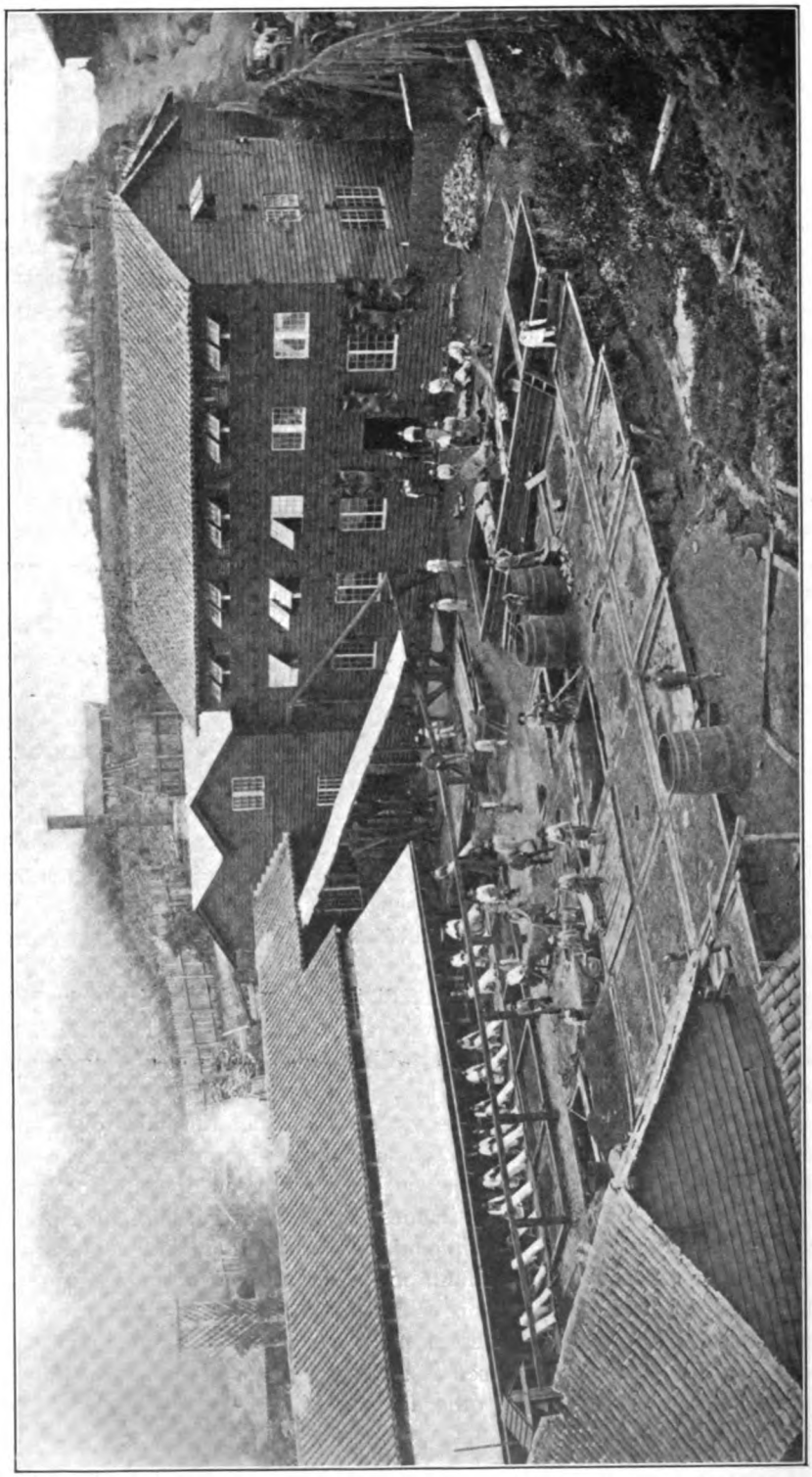
SOLE LEATHER

In tanning sole-leather, the hide is soaked for several days in vats, first in a weak solution and then in a stronger liquor, made by steeping oak or hemlock bark in water or by dissolving prepared tanning extracts. This causes a chemical change in the fiber of the hide, rendering it proof against the ordinary process of decay to which the untanned skin is liable, and making it pliable instead of hard and stiff, as hides are when simply dried without tanning. The tan-liquor is made stronger from time to time, and the hides are frequently "handled" or moved about, so that they will come in contact with fresh liquor. After five or six months, or sometimes after a year or more, the hide has absorbed all of the tannin which it will take up, and the tanning is complete. The hides are then removed from the "pits," washed, oiled, dried, dampened and rolled by brass rollers, which give the leather a gloss on the hair side.

UPPER AND FANCY LEATHER

Other grades of leather are tanned and finished by variations on the above process. Thick hides are often split thin by machinery and the parts retanned and finished separately. The parts from the hair side are most valuable and are called "grain" leather, and the inner parts or "flesh splits" are made into a variety of leathers by waxing, oiling and polishing. After tanning, nearly all leather must be finished by being "stuffed" with tallow, stearine, or oils such as olive, castor, cod liver, whale or sperm, and polished by rubbing with brushes and rollers. Patent and enamelled leathers are coated with black varnish.

Leathers for different purposes are made from the hides of different animals, and are tanned by different substances and by a great variety of processes. Goat skins are tanned in large numbers for soft shoe leather (called "glazed kid" and other names) by immersing them, after preliminary unhairing, cleaning and softening (or bating), in a solution of chromic acid, bichromate of potash or alum, and then in a bath of sodium hyposulphite. Many glove leathers are chrome tanned. Chamois leather and wash leathers are made of sheep skin by thoroughly impregnating it with fish oil. The excess of oil used is squeezed out, and under the name of "degras" is used in currying other leathers.



TANNING HIDES, CHILE.

The skins of nearly all animals are utilized to a greater or less extent when tanned or dressed. Calf skin makes a soft leather for boots and shoes. Lamb skin, dog skin, deer skin, buck skin, doe skin and rat skin are used for gloves. Kangaroo, alligator, whale, porpoise, seal, walrus, snake, beaver tail, and hundreds of other skins are used in making fancy leathers, for hand bags, purses, belts and miscellaneous articles.

IMITATION LEATHER

There are quite a number of materials sold as imitation leather. Most of them are made of strong cloth, covered with drying oil like linseed, mixed with various gums or other solid substances. The exact composition is usually kept secret by the manufacturers. Imitation leathers are used for almost all purposes for which leather is used, except for shoes and gloves.

SWINE.

The United States is the greatest hog raising country. Large numbers are raised in Germany, Austria and Russia, as well as in nearly all other parts of the world. Live hogs are seldom exported. Pork is a very important food and is eaten almost everywhere except by Jews and Mohammedans. Chicago, Kansas City and Omaha are the chief centers of pork packing. The meat is sold fresh (refrigerated), salted, pickled, smoked, and in the form of ham, bacon and sausage.

LARD

Lard is one of the main products. It is the rendered fat of the hog. Its chief use is as a food stuff. Lard oil is obtained by placing lard in woolen bags and submitting it to heavy pressure. It is used for lubricating and lighting and as an adulterant for other oils. Stearine for candle making remains after the oil is pressed from lard.

All parts of the hog are utilized. The hair is sold for mixing in mortar, the intestines when cleaned are used for sausage casings, the bones are carbonized and sold to sugar refiners, or with all other refuse are made into fertilizer.

Pigskins are made into leather for saddles and satchels.

BRISTLES

Bristles are obtained commercially, chiefly from Russia and China. In these countries the pig is much like its ancestor the wild boar and has not been improved by breeding. The bristles of these animals are much more valuable than those of the improved breeds raised in America and are used for making brushes for many purposes.

SHEEP.

Sheep are raised throughout the temperate parts of the globe. Australia, Argentina, Uruguay, Russia and the United States are the leading sheep raising countries. The different breeds have developed from one original stock and are due to differences in climate and food and to selection in breeding. Some breeds, like the Southdown, are most valuable for mutton, and some, like the Merino, on account of the fine quality of their wool, and in these respects each breed differs somewhat from the others.

Merino sheep originally developed in Spain and for several centuries were raised nowhere else. Saxony merinos, including Rambouillet, Negretti and Electoral, are the important varieties. Various breeds of sheep have developed in Great Britain, prominent among which are the Southdown, Lincoln, Dorset, Highland, Cotswold, and Leicester. The fat-tailed sheep are peculiar to certain parts of Asia and Africa.

Live Sheep are exported from Argentina, United States, Canada, Australia and New Zealand.

MUTTON Mutton is not so large an item as either beef or pork in the world's commerce, although Argentina, Australia and New Zealand ship many frozen carcasses of sheep and lambs to England. The flesh of sheep is seldom eaten in Spain except by the very poor.

Sheep's milk is used in France to make genuine Roquefort cheese. Sheep's bones are not so large, and therefore less useful, than those of cattle. Tallow is rendered from the fat of sheep as well as from that of cattle.

Cat Gut used for strings for musical instruments, tennis racquets, and other purposes is nearly all prepared from the intestines of sheep.

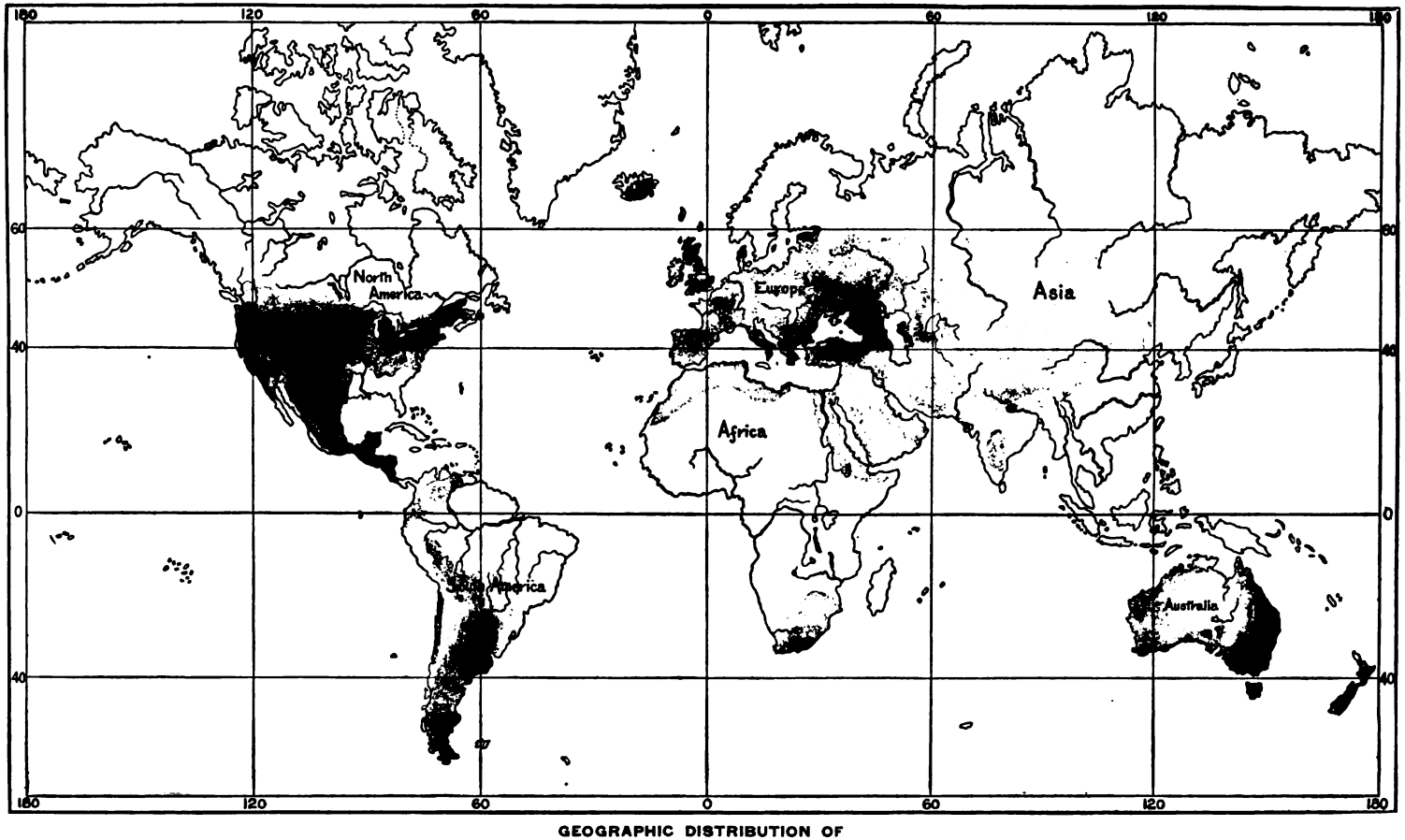
SHEEP SKINS Sheep skins are dressed for use as rugs by treating the flesh side with powdered salt and alum. They are also employed in some parts of the world for clothing. Fashionable furs are made of the skins of unborn and very young lambs and according to the breed of the animal and the part of the world from which they come, they are known as Persian lamb, broadtail, Spanish Astrakhan, Thibet, etc.

The wool is shaved off from the skins of sheep which have been slaughtered, and the skins themselves, called "roans," are used for making leather. (See Tanning.) They are often split so as to get leather of even thickness and the two parts tanned separately. The pieces from the hair or "grain" side are called "skivers," and those from the flesh side, which are of poorer quality, are called "fleshers."

Moroccos and colored leathers are tanned and finished by different processes and are used for many purposes, such as linings in boots and shoes, bookbinding, handbags, pocket-books, hat bands, etc.

Chamois leather is made by dressing sheep skins with fish oil. Gloves are made of lambskins dressed with oil to imitate kid, deerskin and dog skin. Parchment is made of sheep skin (sometimes of goat skin) by scraping and rubbing down with chalk and pumice.

WOOL Wool is the most important animal fiber and the most valuable product of the sheep. It differs from hair in being generally finer and in having a surface which under the microscope is seen to be covered with a great number of minute overlapping scales. The surface of hair sometimes shows scales, but they are few in number and much less prominent than on wool. These scales with their projecting edges, give to wool its felting quality, by causing the fibers to adhere to each other. Both hair and fur are produced by many animals, the fur being shorter and



GEOGRAPHIC DISTRIBUTION OF

SHEEP (AND SOURCES OF WOOL)

finer and similar to wool. While hairs such as those from the horse and cow are straight, the wool of the Merino sheep is beautifully wavy and crimped. In the finest wools there are sometimes as many as thirty crimps to the inch. Coarser wools such as the Leicester and Lincoln have only a few crimps in an inch. There are great differences in the length of fiber or staple of wools from various breeds of sheep, and on this basis they are divided commercially into clothing, combing and carpet wools. The shortest and finest are the pure bred merinos and are called "clothing" wools. These are used in making the very finest woolen yarns and fabrics. Cross breeds of the Merino and Lincoln sheep yield wools which are stronger and longer than the pure Merino and not so coarse as the pure Lincoln. These wools are especially used in fine grade goods, such as worsteds or dress goods. Clothing wools come from Germany, Argentina, Australia, South Africa, Russia and the United States. The longest and coarsest of the good wools are such as those of the Lincoln and Leicester breeds and are called "combing" wools. These are used in making worsted yarns and fabrics, for carpets and blankets. England, Scotland, France, Australia, and the United States supply most of these wools. Lamb's wool is used with certain furs in hat making.

In Russia, Asia Minor, China and Spain there are large numbers of sheep which have undergone no improvement by mixture with the Lincoln or Merino breeds. These are called native sheep, and they produce "native" or "carpet" wools. The wool of sheep as it grows, is saturated with a natural grease called wool fat, yolk or suint. This causes the wool to shed water and prevents it from tangling or felting on the sheep's back. Where it is abundant in the wool it also causes dirt to stick, and for this reason many sheep are washed before shearing. The wool as it is clipped does not fall apart like bunches of hair, but holds together like a skin, and is rolled up and tied in a bundle, each fleece by itself. When the fleeces are opened they are spread out and sorted into several grades, according to the length and fineness of the fiber, because the wool on some parts of the sheep's body is of better quality than on other parts. The wools from the poorer breeds of sheep are not sorted into as many grades as the finer wools, and the fleeces of the poorest kinds do not hold together in the form of a skin.

After sorting or "stapling," the wool is "scoured" by washing with soap and water to remove the grease, potash and dirt. In scouring some very greasy dirty wools loose as much as 80 per cent. of their weight, the grease itself not infrequently being over 60 per cent. The wool fat is by some processes saved and sold as lanoline, or converted into soap. In the next process, "carbonizing," the scoured wool is treated with acid, which destroys all burrs or other vegetable matters which are tangled in the fleece.

The next step is to convert the wool into yarn. For this purpose it must be "carded," if it is to be made into a woolen yarn, or it must be "combed," if it is to be made into a worsted yarn. In carding the wool is passed over a cylinder set with innumerable fine wire teeth which serve to tangle the fibers in all directions, after which it is loosely spun into woolen

yarn which, in turn, is woven into woolen goods. The wool used for woolen yarns is usually short staple; the yarns are loosely twisted and largely depend for their coherence upon the felting property of the wool. For worsted yarns the wool is combed, in order to lay the separate fibers parallel to each other, after which it is spun into yarn, usually with a tighter twist than that given to woolen goods. In felt, the wool or fur is neither spun nor woven, but is simply tangled and pressed, or kneaded or pounded. The scales with which wool and fur are beset greatly facilitate the felting process, and the more numerous the scales, the more readily will the wool or fur felt. Materials which, like vegetable fibers and silk, lack these scales, will not felt at all.

In all of the processes of making wool into yarn and cloth there are portions consisting of short, broken or tangled fibers which do not pass through the machines. These are termed "waste." The best grades of waste are mixed with good wool in yarns, or else spun with "shoddy." Shoddy is made by tearing up old woolen goods, rags or cloth cuttings in a machine until the fabric and the yarn of which it was made are reduced to a mass of loose fibers. It is mixed with wool in the manufacture of cheap yarns and fabrics.

There are many fabrics on the market made of wool, some of the most important of which are woolen, worsted, felt, flannel, serge, broadcloth, cheviot, cassimere, carpets, tapestry, blankets, hosiery, underwear, shawls, velvets and plushes. Woolen fabrics are often adulterated with cotton, and there are many mixed goods woven with warp threads of cotton or silk and weft of wool, or vice versa. Carpets frequently have a warp or a backing made of jute, hemp, linen or cotton.

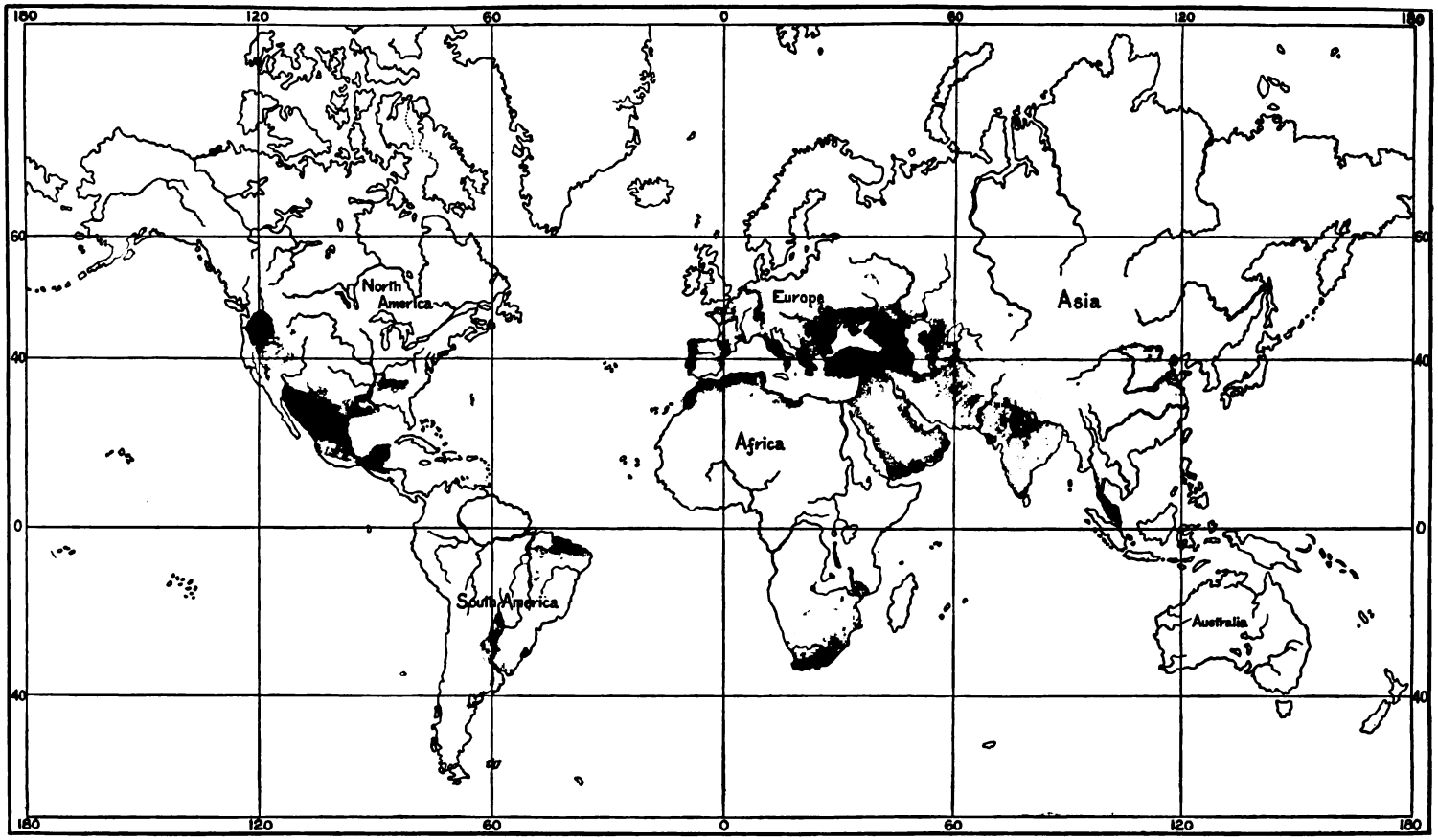
GOATS.

Goats are raised in large numbers throughout western Asia, particularly in Asia Minor. There are many in the mountainous parts of southern Europe and northern Africa and in Mexico and Texas. In some countries they are used as beasts of burden.

There are several distinct varieties of goats (*Caprus* species) such as the common goat, the Angora and the Cashmere, and among these there are numerous breeds.

Goat's flesh is eaten in many places, that of the kid being most highly esteemed, but in civilized countries it is not a popular article of diet. The meat of the Angora goat is said to be equal to mutton. The tallow is used for making candles and the largest horns like those of deer.

Goat's milk is in common use among the Arabs and in Italy, Spain and other Mediterranean countries, as well as in Cuba. It is customary where this beverage is used, to drive a flock of goats about the streets of a city and milk the animal at a customer's door.



COMMERCIAL SOURCES OF

GOAT AND KID SKINS

GOAT SKINS Goat skins are used by Moors and Arabs for making bottles to hold water and wine and for making morocco leather. Some skins, particularly such as the Angora, are used for rugs and in parts of the world for clothing. In the United States and Europe very large numbers of goat skins are imported for leather making. (See Tanning.)

Glazed kid and other soft leathers for shoes are made of goat skins tanned with chrome. Morocco and fancy leathers are made for bookbinding, shoes, and miscellaneous articles by tanning with sumac or other vegetable tans. Much morocco is made also of sheep skin.

The original cordovan and morocco leathers were made in Spain and northern Africa of goat skins.

Kid skins are made into glove leather by "tawing," a process in which, after thorough softening, the damp skins are tumbled about in a drum containing alum and salt, and then after drying are tumbled again in another drum with a mixture of oil, flour and egg yolk. Glove leathers are also made of sheep, lamb, deer, rat and other skins.

GOAT HAIR Goat hair, as it is known commercially, comes from the common goat. It is obtained in Turkey, Russia, Asia Minor and India. It is usually from three to four and a half inches long and white, red or black in color. It is used in making coarse blankets and carpets.

Angora or Mohair comes from the Angora goat and is produced in South Africa, Turkey and the United States. It has a very glossy fiber often ten inches in length and is used in making dress goods, braids and plushes.

CASHMERE WOOL Cashmere wool is produced in Thibet and the highlands of central Asia by the Cashmere goat. This animal has a fine soft wool and longer coarser hair. The wool is used in making true Cashmere shawls, which are very highly valued on account of their beauty and durability. Most goods commonly sold as cashmere are made of sheep's wool.

CAMELS.

CAMEL HAIR The camel produces a fine wool which is especially suited for making hosiery, underwear and shawls. It is also employed in making fine brushes. At certain seasons of the year the hair of the camel loosens and is plucked out by hand.

In China, Arabia and other parts of Asia, Russia, Turkey and many parts of Africa the camel is a common beast of burden. Its flesh is frequently eaten, its skin tanned, and its milk used as a beverage or made into cheese.

There are two important varieties, the two-humped or Bactrian camel and the one-humped camel or dromedary.

ALPACA WOOL Alpaca wool is a valuable fiber obtained in Peru from the alpaca, an animal of the camel tribe. This wool is fine, strong and particularly long. It is used for making dress goods. The llama and vicuña are similar animals, the skins and hair of which are used for robes in Peru. Vicuña robes are sometimes exported. Most of the so-called vicuña fabrics on the American market are made of sheep's wool. Llamas are used in Peru as beasts of burden.

MISCELLANEOUS ANIMALS.

DEER Deer and antelope of many species furnish food and clothing in some districts. The reindeer is the chief domestic animal in the coldest parts of northern Europe and Asia. Deer horns and stag horns are used for ornaments and in the manufacture of knife handles and various fancy articles, and are obtained in India, Ceylon, Siam, China, Russia, Germany, Africa, Canada and Central America. Deer skins are used for rugs and in leather making, chiefly for buck skin and doe skin.

IVORY Ivory is obtained chiefly from the tusks of the elephant, in India and in Africa. It is used for fancy carvings, billiard balls, knife handles, piano keys, combs and vaccine points. The Indian elephant displays much intelligence and is trained as a beast of burden. Elephant's hide has been tanned, but this leather is not often used. Small amounts of ivory come from the tusks of mammoths dug up in Siberia where they lived in past ages, from hippopotamus teeth, narwhal horns, and the teeth of the walrus. Walrus skin is tanned to make a fancy leather.

FURS Most of the valuable furs of commerce come from the cold countries of the northern hemisphere, with the exception of the skins of monkeys and of the cat family. London and Leipzig are the great fur markets. In addition to the furs used in Europe and America for mats, robes, muffs and other clothing, enormous numbers are sold in the colder parts of Asiatic Russia and China. Here there is a market not only for costly furs but also for large numbers of cheap furs which in America are not stylish. Sea otter is probably the most expensive fur in the world, a single skin being sometimes worth $1,200. Russian sable and silver fox, while costly, are more common.

Wild animals of the cat family furnish many skins for rugs and ornamental purposes. Prominent among these are the tiger, lion, leopard, panther, lynx and wild cat. Skins of the domestic cat, when dressed and dyed, are commonly worn as furs under various names.

Skins of dogs are also used in fur rugs and robes, and leather from the hide is made into gloves. The Eskimo dog is most important as a draught animal, and dogs are used similarly in Belgium and other parts of Europe. Wolf skins are used principally for knapsacks. Fox skins are among the most popular furs, the common red fox furnishing most of the skins used. The skin of the silver gray fox is very valuable, being worth up to $200.

Skins of bears, raccoons, wolverines, skunks, martens, weasels, ermines, minks, sables, monkeys, moles, chinchillas, otters, beavers, nutrias, musk rats, squirrels, and opossums are used as furs for rugs, robes or clothing.

Handsome furs are also obtained from sheep, lambs and goats.

Many of these furs are used in their natural condition, simply cleaned and dressed, so that the skins are soft and flexible. A great many of them, such as otter, beaver and nutria, have long, coarse overhairs, which must be plucked out in order to uncover the more beautiful fur. Many cheap furs are dyed and otherwise prepared to imitate more costly varieties.

SEALS Seal skin is a fur, which as it is sold, bears little resemblance to the pelt in its natural state. The removal of the long, coarse overhairs leaves a grayish or light brown fur, which is dyed a desirable color, care being taken to dye the tip of the fur darker than the base. Seal skins come on the market from Pribilof and other islands of Bering Sea and adjacent parts of the north Pacific Ocean, and a few from Lobos Island off the coast of Uruguay and from the South Shetland Islands. Imitations of seal skin called "electric seal" are made from the skins of the cony or European rabbit, and cheaper imitations still, are simply plushes.

In addition to the fur seal, there are several other kinds of seals, such as the hair seal and the harp seal. The skins of these and the skins of sea lions are used for making seal leather.

Seal Oil is made from the fat of seals, and, like fish oils and whale oils, is used for leather dressing, lubricating and burning.

ANIMAL HAIRS In addition to wool, horse hair, cow hair, and bristles, the hairs of a variety of animals find industrial applications. One of the principal uses of such hairs is for making felt hats. For this purpose, the fur is cut from perhaps one-third of all the rabbit skins marketed. Australia and New Zealand are the chief countries supplying rabbit skins.

The **nutria** or coypu furnishes a large percentage of the fur used for hat making. This animal inhabits river banks in the neighborhood of the Rio de la Plata, in South America. Its fur is covered with coarse hairs which are first removed. When prepared, the fur of the nutria resembles that of the otter, and is sometimes sold as such.

Clippings from muskrat, beaver, seal, otter and mink skins by manufacturers of clothing are sold to hat-makers, who cut off the fur and use it for felting.

Badger hair is chiefly used in shaving brushes.

MUSK The Musk Deer inhabits the mountains of India, China, Thibet and Siberia and furnishes a very important perfume, musk, from a small sac in the body of the male animal. Some other animals, such as the musk rat and musk ox, produce a similar substance.

The civet cats of Africa and Asia supply a similar perfume.

The beaver yields, from a small sac in its body, a medicinal substance known as castoreum.

Ambergris (see Whales).

WHALES

Whales of several species furnish articles of commercial value. The Greenland whale fishery is now the most important.

Whale oil or "train" oil is obtained from the blubber or fat of whales, usually by cutting up the blubber and allowing the oil to drip out. It is then heated and strained. It comes in three grades, "spring," "summer" and "winter" oil. The best is winter sperm, from which the solid wax or spermaceti has deposited on cooling. Whale oil is extensively used in leather dressing, in the preparation of manila rope, for burning and soap making. The best grades of sperm oil are employed for lubricating light machinery and in the recoil of large cannon.

Spermaceti is a wax which occurs chiefly in the head cavities and (held in solution by sperm oil) in the blubber of the sperm whale. It is used in candle making, in pharmacy and for waxing cartridge covers.

Whalebone is obtained from the mouth of the whale and is not bone, but a substance in its nature similar to hair. In the upper jaw whales have a series of long plates hanging from the roof of the mouth, with bristly fringes on each side of the tongue. These fringed plates are the whalebone or baleen. Whalebone is used for stiffening in corsets and dresses, for whips and canes and for making brushes. It is sometimes split fine and woven into silk goods to stiffen it and make it rustle.

Ambergris is a fragrant substance formed in the intestines of the sperm whale. It is used as a basis for perfumes and commands a very high price.

Sperm whales have teeth in their lower jaws which are sometimes used as a substitute for ivory.

Porpoise leather is made by tanning the skins of the white whale.

TORTOISE SHELL

Tortoise shell consists of plates from the back of the hawk's bill turtle. This animal is captured in warm waters in many parts of the world. The so-called shell is used chiefly for combs and is much imitated in celluloid. The eggs and flesh of the green turtle are used for food.

SPONGES

Sponges are obtained commercially along the shores of the Mediterranean from Sicily and Algeria, eastward, and on the shores of the Bahamas, Cuba and other West India islands. They are the cleaned skeletons of certain peculiar animals (*Spongidae*) which resemble plants and grow attached to rocks, shells or corals in tropical waters. In life, the sponges are covered with the soft gelatinous body of the animal, which is frequently beautifully colored and delicately formed. The sponges are obtained either by dredging or diving; the gelatinous parts, which soon decompose, are washed off, and the cleaned sponges bleached, and finally washed in a weak solution of glycerine to prevent them from becoming brittle. Sponges are of many different shapes, sizes and qualities. Some animals of this family have skeletons which instead of being soft, absorbent and elastic, are hard and brittle. These are not commercially valuable.

FISH.

Fish are among the world's chief foods. Fresh fish are sold in most countries in districts near the sea coast. In many places, large rivers and lakes supply considerable amounts of fish to the adjacent country. The most important fisheries in the world are the "Grand Banks," off the coast of Newfoundland. Cod and haddock are the principal fish caught there. Almost as important are the great fisheries of the North Sea, which yield haddock, herring, sole, cod and mackerel. Other important fisheries are along the coasts of the northern Atlantic and Pacific oceans. The fisheries of the coasts and rivers of China supply a very large quantity of food.

COD FISH Cod Fish are caught in the north Atlantic and north Pacific oceans. They are mostly salted and dried, and find an enormous sale in Roman Catholic countries of Europe, Central and South America and the West Indies. The exports are chiefly from Norway, Newfoundland, Canada and the United States.

Cod liver oil is obtained by heating the livers of the cod fish. The best quality oil is used in pharmacy and the less pure, darker colored oil in dressing chamois and other leather. The livers of some other fish yield oil, often sold under the name of cod oil.

SALMON Salmon are caught in greatest numbers in the rivers on the west coast of North America, from Oregon to Alaska, although many are taken in Japan, Siberia and Norway. Most of them are canned, although some are refrigerated and shipped to eastern points.

HERRING Herring are taken in the north Atlantic and are salted, pickled or smoked for market. In Maine, small herrings are packed in oil and come on the market as sardines.

Sardines are caught in the Mediterranean and on the Atlantic coasts of Portugal, Spain and France.

Other varieties of fish, too numerous to mention, are extensively used. A few of the best known are: mackerel, shad, blue fish, weak fish, catfish, etc.

The **cuttle fish** supplies a secretion from which true sepia pigment is derived. The shell of the cuttle fish, called cuttle bone, is sold for canaries and other caged birds.

Caviare is the prepared and salted roe of sturgeons. It is made on the shores of the Caspian and Black Seas, the Great Lakes, Delaware Bay and some other places.

ISINGLASS Isinglass, a very pure gelatine used in confectionery and in clarifying wines and beer, consists of the cleaned and dried swimming bladders of sturgeon and some other fishes. It is imitated in gelatine obtained from other sources. The name isinglass is incorrectly applied to the mineral substance mica on account of its similar appearance.

Beche de mer, trepangs, or holothurians, are popular in China for making soup. These animals, often called sea cucumbers or sea slugs, are captured and dried in large numbers on the coral reefs bordering the islands adjacent to southeastern Asia.

Menhaden Oil is prepared from the heads and intestines of fish, especially of the menhaden or moss bunker (*Alosa menhaden*) of the Atlantic coast of America. It is used in preparing leather, in paints and in oiling ropes.

Fertilizers are prepared from the refuse of fish canneries and in some places from the entire bodies of fish which are not otherwise valuable.

SHELL FISH.

OYSTERS Oysters are the most valuable product of the fisheries of the United States. More than half of all produced in this country come from Chesapeake Bay. Oysters are obtained also on the coasts of Europe, and in many other localities.

Lobsters and crabs as well as oysters and clams are sold both fresh and canned.

PEARL OYSTERS Pearl oysters are important because they produce pearls and mother-of-pearl. These shells are found off the coasts of Ceylon, the Society Islands, the Isthmus of Panama, and in the Gulf of California, the Red Sea and the Persian Gulf. The shells are ready to gather when they are about six or seven years old. Great care is taken to leave the younger shells undisturbed. Pearls are formed by matter which the animal secretes to cover up grains of sand or other foreign substances which have gotten within its shell and cause irritation, or as the result of disease. The best pearls and best mother-of-pearl are found in the Persian Gulf, at Ceylon and in the Society Islands. The oysters (*Meleagrina*) are gathered by divers who are able by practice to remain under the water for a minute and a half to two minutes at a time. Pearls are used as jewels. Mother-of-pearl is used for knife handles, ornaments, buttons, inlay work, etc.

The fresh-water mussels are used to some extent as mother-of-pearl and have been known to produce fine pearls.

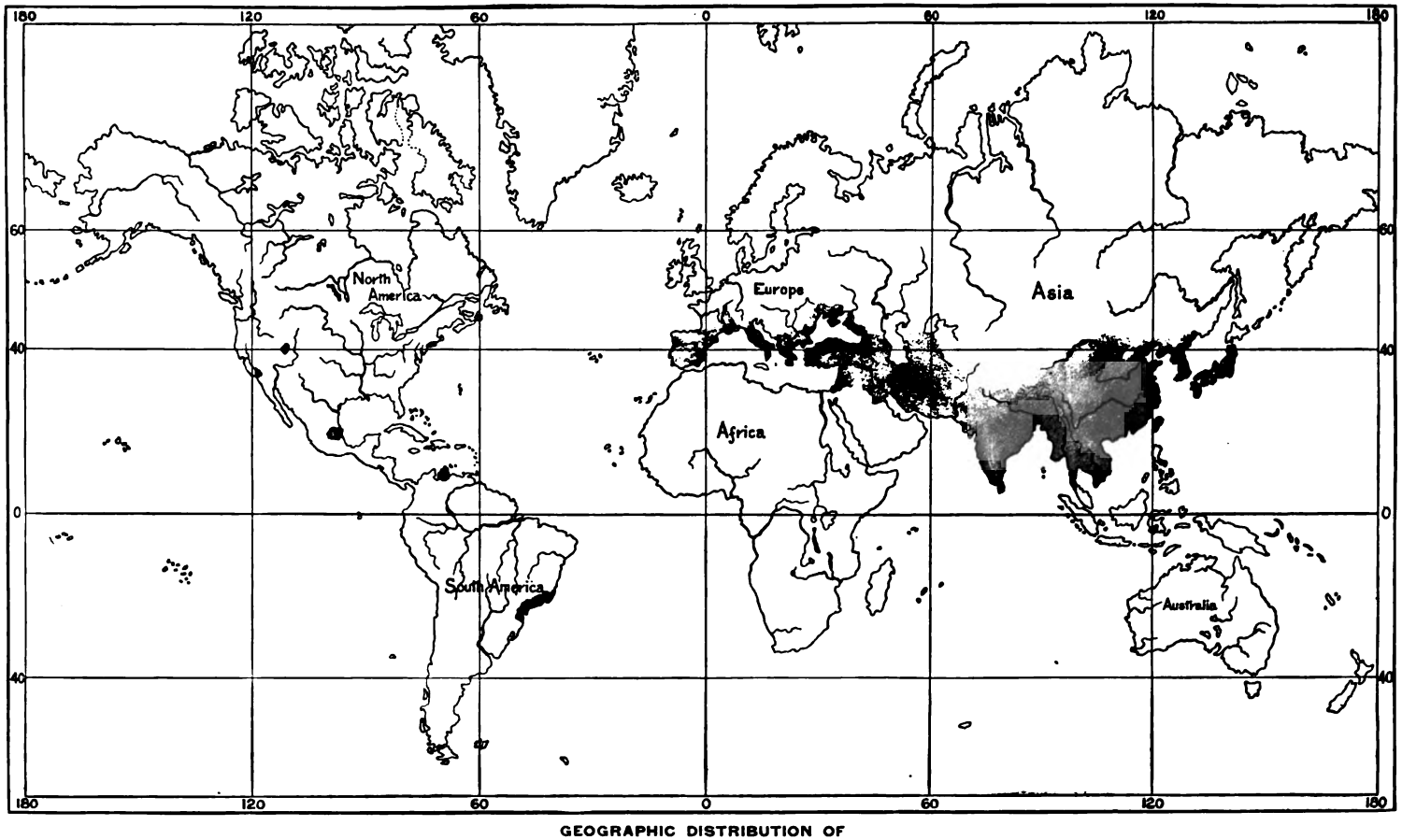
The Abalone (*Haliotis*) shell comes principally from the shores of the Pacific and supplies a very brilliant mother-of-pearl.

Shells of other kinds are used for cutting cameos. Snails are used in some countries for food.

Corals are obtained in many places and are sold as curiosities. Red coral, chiefly from the Indian Ocean, is used in jewelry.

INSECTS.

SILK The silk of commerce is obtained from the cocoons of several species of insects. In these species, the caterpillars (or worms) form their cocoons of an unbroken strand of silk which is secreted by the insect in its body as a jelly-like substance. This hardens on exposure to the air as the worm forces it out and winds it about its body. The common silk worm (*Bombyx mori*) is not a wild insect, but is reared in cultivation exclusively. Two distinct varieties are raised, one of which, the single-brooded, or "univoltine," of temperate regions, produces only one generation a year. The other form, known as the many-brooded or "multivoltine" worm, pro-



GEOGRAPHIC DISTRIBUTION OF

SILK WORM CULTIVATION
PRODUCTION OF RAW SILK

duces several generations in a season. The single-brooded form produces the greater amount of the silk of commerce. The cocoons of the multivoltine variety are more difficult to reel, contain more floss and, therefore, yield more waste silk than the univoltine cocoons. Silk worms are subject to diseases, which often cause the occupation of rearing to be unprofitable.

The eggs of the univoltine worm require a certain amount of cold for their healthy hatching. After the eggs hatch, the young worms are fed on mulberry leaves. They grow rapidly for about four weeks (sometimes a little longer) during which time they shed their skin (or moult) four times. When fully grown they are about three inches long and of a waxy white color. They are then placed on twigs or bunches of straw to spin their cocoons. Most of the cocoons are used for reeling after the chrysalis within them has been killed by heating or steaming (called "choking" the cocoons). A sufficient number of cocoons are reserved for the moths to emerge from, so that more eggs can be procured.

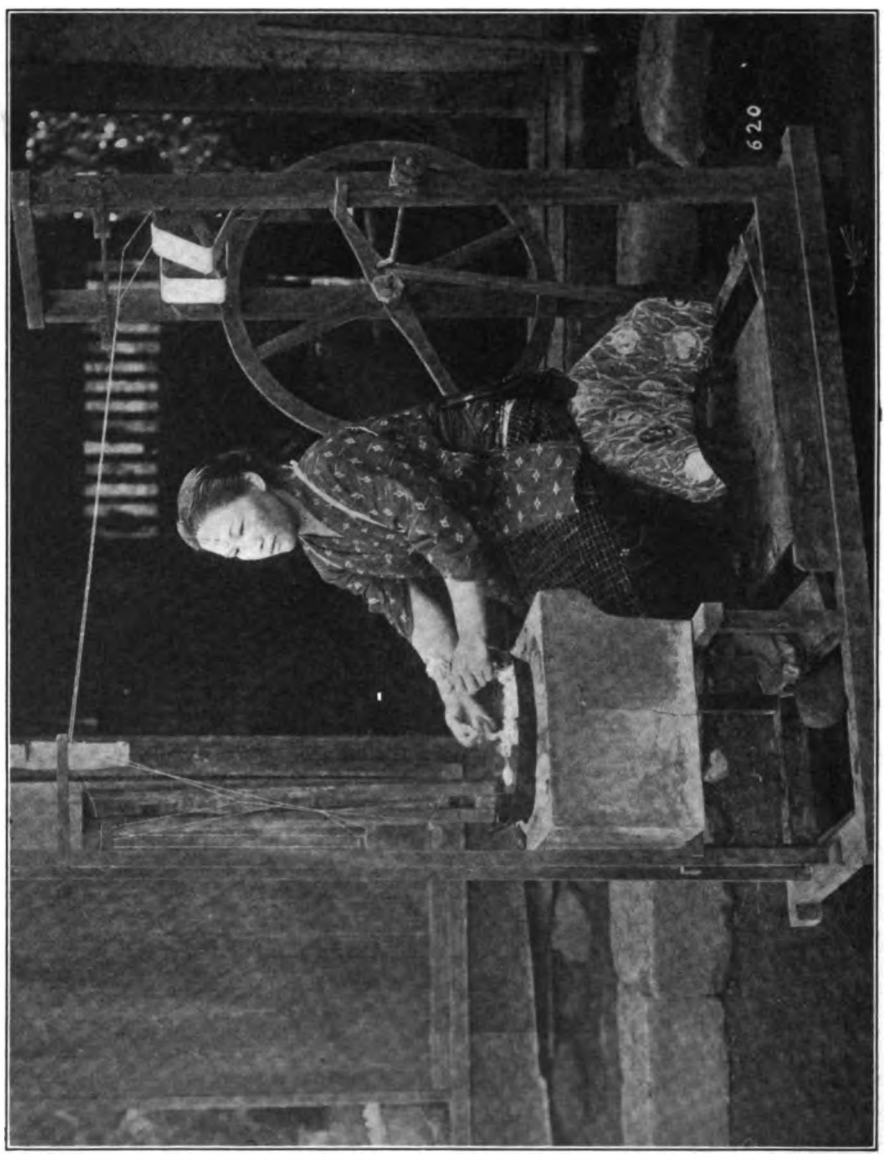
The common silk worm is a native of China, and it was in that country that the value of silk was first discovered. It is now cultivated in parts of the world where the climatic conditions are suitable and where the inhabitants work for sufficiently small wages to make rearing and reeling profitable. The insect cannot be reared economically in the United States because of the high rate of wages, and it is, therefore, necessary to import raw silk for purposes of manufacture.

Raw Silk is obtained by unwinding or reeling the silk from the cocoons, but since that from one cocoon is too fine and too weak to be handled, the threads from several cocoons are reeled into a single strand. The cocoons are softened by being placed in warm water, and the tangled outer portion, called "floss," is brushed off and forms silk waste. Having found the end of the strand on each cocoon, the operator passes it with others from several cocoons twisted to a single thread, through an agate, over pulleys and upon a wheel which turns slowly. When the cocoon becomes unwound the operator replaces it by another and thus deftly keeps the threads of equal thickness. After a certain amount is reeled and dried it is twisted into hanks. This reeled silk is called raw silk and hundreds of cocoons are required to make a hank of it.

The principal silk producing countries are China, Japan, India, and the countries bordering the Mediterranean, particularly Italy, southern France, Greece, Turkey and western Asia.

China produces most of the raw silk of commerce, and Japan and Italy each about one half as much. India imports more silk than it exports. The United States imports cocoons as well as raw silk.

Thrown Silk, used for weaving, is of two kinds, "tram" and "organzine." Tram is made of two or sometimes more strands of raw silk loosely twisted and is used for the woof of silk fabrics. Organzine is made of a number of strands of raw silk strongly twisted and is used for the warp of silk fabrics.



REELING SILK JAPAN.

The principal fabrics made of silk are: silk, satin, plush, chenille, crape, crepon, gauze, damask, brocade, pongee and ribbons. Silk thread and cord are also extensively used. The United States is among the leaders in the manufacture of silk fabrics.

Silk Waste is the "floss" (or outer tangled mass of silk supporting the cocoons, which cannot be reeled) and the "reel tailings" (that which is left when the reeling of each cocoon is completed). It is imported by silk manufacturing countries in considerable amounts.

Spun Silk or schappe silk is made from pierced cocoons (from which the moths have emerged) and from waste silk. It is manufactured by cleaning and carding the waste and then spinning it into thread in somewhat the same manner as cotton is spun into thread. Fabrics made of spun silk are cheaper than those made of fine silk thread.

Wild Silk. There are other caterpillars that produce silk. These are the wild worms of China and India, the silk of which is called "tussah" or "tasar," and that of Japan which is known as "Yamamai." The moths are large, buff colored insects and the worms usually feed on oak leaves. The silk is somewhat inferior to that from the cultivated species, and is used for pongee, plush and coarser textiles. Other less important species of India produce silk that can be carded only.

(See Artificial Silk.)

THE HONEY BEE

The honey bee (*Apis mellifica*) lives in colonies. The wild swarms usually select a hollow tree for their home. Domesticated swarms are supplied with hives with removable frames. Each hive has one queen, thousands of workers, and may have many drones. The queen lays the eggs. The workers, stunted females, collect food and building material, build cells, and take care of the brood and honey. The drones are the male bees. They cannot work because they have not the necessary organs. Wax is secreted between the abdominal rings of the workers. This they chew and stick on at the top of the frame, building down. The finished combs consist of two sheets of horizontal, six-angled prismatic cells, with the openings turned toward the outside. While the building is still in progress some of the workers begin to collect. They gather nectar which they digest into honey, forcing it out through their mouths. They fill the cells with it, and seal them with wax. Into many of the cells in the center of the hive the queen lays fertilized eggs, one in each. These become workers. Some slightly larger cells receive one unfertilized egg each. These eggs develop into drones. A few large irregular cells receive one fertilized egg each. These eggs develop into queens. Many of the other cells are used as store-rooms for "bee's bread" (pollen) which is mixed with honey for food for the larvae. The rest of the cells serve for storing the honey. To prevent waste of labor the beekeeper aids the bees. He furnishes them straight frames and "starters" for the combs. Starters or foundations are artificial plates of wax, to form the beginning of the combs.

Honey. When the cells in a frame are filled and sealed, the frame is taken out of the hive, the caps of the cells shaved off, and the honey extracted by a centrifugal machine. This furnishes extracted honey. The empty combs are returned to the hive to be re-filled by the bees. For comb honey small frames (sections), which hold just about a pound of filled comb are put in the hives. Honey is graded on the market according to the flowers which yield it. White clover, buckwheat, heather, mesquite, horsemint, and orange blossoms yield some of the best. A light colored honey is usually preferred. Honey is produced in enormous quantities in northern Europe and the United States. To some extent it is produced in all parts of the world. It is used largely as a food, in the manufacture of confectionery and sweetmeats, and to some extent in medicine. A variety of drinks is prepared from it. Extracted honey is often imitated by, or adulterated with, glucose or syrups. Sometimes bees are fed with cheap syrup, which they seal up just like honey. The resulting comb honey is, of course, only comb syrup.

Beeswax is obtained from the capping of combs for extracted honey, and from condemned combs. It is melted usually by the heat of the sun, and moulded into flat cakes of various sizes. Wax from new comb is light yellow; that from very old comb is brown. It can be bleached to a pure white by the action of sunlight and moisture, or by chemicals, such as chromic acid, nitric acid, etc. Wax is used for candles, waxing floors and threads, artificial plants, figures, salves, and in encaustic painting. Wax is produced in the largest quantities in Europe, northern Africa, and Chile. Almost all other countries produce some wax. There are many substitutes and adulterants for beeswax. The most important of these are stearine, paraffine, Japan wax, carnauba wax, pela wax, bayberry wax, etc.

LAC

Lac is a resinous material found on the twigs of many trees of India (especially *Butea frondosa* and *Ficus religiosa*). This substance is caused by an insect (*Coccus lacca*) belonging to the order of plant lice and very closely allied to the cochineal insect. The lac insect punctures the twigs for food and then secretes a large quantity of resinous substance as a sort of cocoon and protection for itself and young. This is known as stick-lac, and being gathered in quantity from wild trees and those cultivated for the purpose it is worked and washed free of useless matter. Red lac dye (before the use of anilines, extensively used) is extracted by the washing. The dried and ground residue is known as seed-lac.

Seed-lac is melted and poured out on broad leaves or on metal plates to harden. The thin sheets which result are called shellac and the thick plates or the drops are called button-lac.

Shellac is dissolved in alcohol to make fine varnishes. The ordinary orange colored shellac is bleached with chlorine to make white shellac.

Sealing wax is prepared by mixing shellac with turpentine and various resins.

Shellac is used also in putties, for sizing paper, stiffening felt hats, etc. Dissolved in a strong solution of borax, shellac and dyes are used for drawing inks and some water colors.

COCHINEAL Cochineal consists of the dried bodies of insects (*Coccus cacti*) that belong to the plant lice family and live on cactus plants in Mexico and Central America. They have been introduced into Algeria, the Canary Islands and the East Indies. The insects are collected and killed by placing them in hot ovens when they become coated with a waxy, whitish powder. When killed in hot water or by steam they appear black and are not so valuable. The principal use of cochineal is as a dye for woolen fabrics. The color is known as carmine and is soluble in water; with alumina and tin salts, scarlet lakes are formed which are used for oil and water color pigments.

CANTHARIDES Cantharides are medicinal preparations used for blistering, plasters, etc. They are made from a beetle (*Cantharis vesicatoria*) called Spanish Fly, common in southern Europe. The insects are bright metallic green with an azure tint, about an inch or less in length and possess a nauseous smell. Allied insects (species of *Mylabris*) are used for similar purposes in India and China.

(See Oak Galls.)

BIRDS.

Poultry and eggs figure largely in commerce. Turkeys, pigeons, and game birds are chiefly of local importance.

EGGS Eggs, aside from their use as food, are valuable industrially. The yolks are used in preparing glove leather and other tawed leathers and the whites (egg albumen) in making some kinds of photographic paper, in finishing fancy leathers, in clarifying sugar and for other purposes.

FEATHERS Feathers and bird skins for ornamental purposes, chiefly for millinery, are obtained from the ostrich, cock, duck, turkey, pheasant, heron, grebe, and a variety of other birds. Great destruction of wild birds caused strong measures to be taken for their protection and there are now stringent laws in this country prohibiting the sale of many kinds of feathers and the killing of certain birds.

Feathers for beds, pillows and upholstery are plucked from the domestic goose and duck. Down is also obtained in small quantity from nests of the eider duck in northwest Europe. Feathers are also used for making flies for fishing. Quills are used in making camel's hair brushes and for minor purposes.

OSTRICHES Ostriches are the largest of all existing birds (*Struthio*). They are natives of the sandy deserts of Africa and Arabia and are domesticated and raised for their plumes, on ostrich farms chiefly in South and North Africa and in smaller numbers in Argentina and California. Ostrich feathers constitute half of the imports of feathers to the United States. The birds are caught and the best plumes carefully cut from the wings and tails once in eight months. For millinery, handsome plumes are made by splitting off part of the quill and binding together two or more in order to get feathers with apparently heavy plumage.

The plumes are then dyed and curled. Poorer feathers are used for making feather dusters. The smaller feathers from the body of the ostrich are also used for millinery. In Argentina and neighboring countries, a wild bird, the Rhea, or South American ostrich, has been extensively hunted and its feathers are still exported.

Edible Bird's Nests come from the Malay archipelago and the southeastern shores of Asia. They are made by certain species of swifts commonly called swallows. These nests are constructed of a gelatinous material and are highly prized by the Chinese for making soups.

GUANO

Guano is used as a fertilizer. It is composed largely of phosphate of lime and is mostly the excrement which has accumulated as a result of the occupancy of dry islands by enormous flocks of sea birds. Some guano is also taken from caves inhabited by bats. Large deposits of guano occur on islands in the Pacific Ocean and in caves in the West Indies and Australia.

MINERAL PRODUCTS.

Mineral Products may be conveniently classified as follows:—

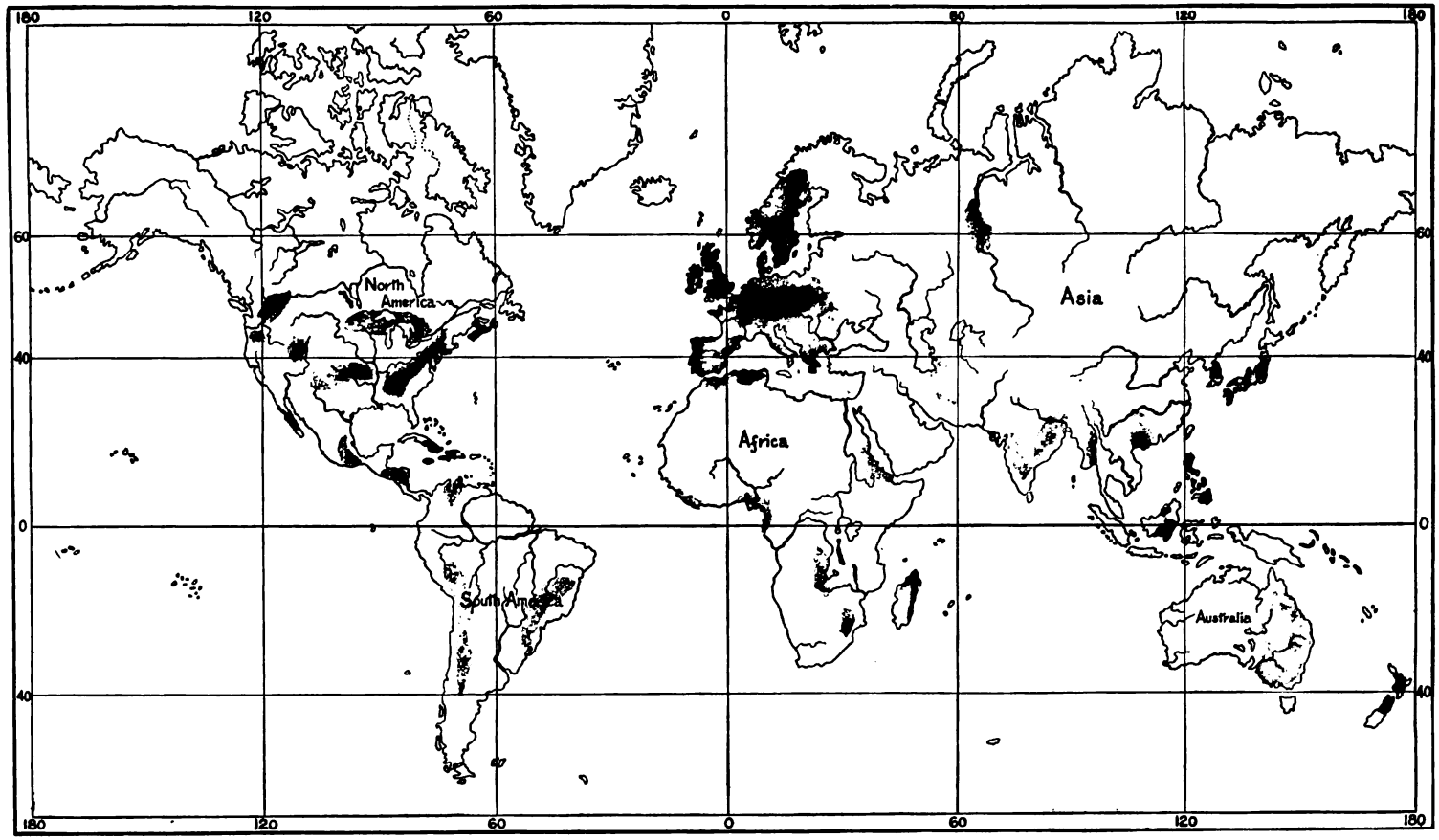
Metals and their ores.
Building Stones.
Cements and cement materials.
Glass, Pottery, brick and materials used in their manufacture.
Hydrocarbons, coal, asphalt, petroleum and their products.
Fertilizers.
Pigments and Dyes.
Abrasives.
Lubricants.
Fibers.
Gems and Ornamental Stones.
Medicinal Substances, Tanning Substances.
Acids, Alkalis and other products of chemical industry.

In the following pages these are grouped according to the important metals which they contain.

IRON

Iron is the most useful metal. It occurs in all parts of the world and in many substances. The United States, England and Germany are the greatest producers of iron. Four minerals are found in sufficient abundance and contain enough iron to be used as ores: hematite, limonite, magnetite, and siderite. Rich deposits in many parts of the world are at present unworked, because of lack of transportation, distance from coal and limestone, cost of working, or on account of impurities in the ore, such as silica, phosphorus or sulphur.

Hematite is the ore most commonly mined and supplies almost three fourths of the iron of commerce. It is found in immense beds in Minnesota and Michigan and is produced in large amounts in Alabama and other states. Abroad, Germany, England, Spain, France and Russia are the greatest



GEOGRAPHIC DISTRIBUTION OF

IRON ORES

producers. Ore of fine quality is mined in Elba and in Sweden. This ore, often called red hematite, is a sesquioxide of iron ($Fe_2 O_3$) and is found in varieties ranging from crystallized to massive, metallic to earthy in appearance and red to black in color. Different kinds are called specular iron ore, micaceous ore, red ocher and clay iron stone.

Limonite or brown hematite is widely distributed. It is a hydrous oxide of iron ($2Fe_2 O_3 . 3H_2O$) and varies from yellow or brown to black in color, and from submetallic to earthy.

Magnetite or magnetic iron ore ($Fe_3 O_4$) and siderite (carbonate of iron, Fe C O_3) are used in much smaller amounts than the preceding.

PIG IRON

Pig Iron is made by smelting iron ore in a blast furnace. The ore, with carefully calculated proportions of limestone and fuel, is dumped in at the top, and the burning of the fuel is assisted by the admission of blasts of air around the bottom of the furnace. An intense heat is developed and the furnaces are kept running night and day for long periods, usually until they need repairing. The limestone acts as a "flux," causing the ore to melt more easily than it would otherwise. Metallic iron and slag are formed and while melted, run down to the bottom of the furnace whence they are drawn off, fresh ore, limestone and fuel being frequently added. The slag being lighter floats on the molten iron and is drawn off separately while the iron runs into ditches and depressions in the sand floor, cooling in the form of bars weighing about a hundred pounds each, called pigs. The fuel used in smelting iron is usually coke or coal. Pennsylvania produces about half of the pig iron made in the United States, largely because of the fact that ore from the Lake Superior deposits can be cheaply transported to the neighborhood of the great coal fields and coke ovens of western Pennsylvania.

Slag is used for railroad ballast and in making cements and fertilizers.

CAST IRON

Cast iron is simply pig iron melted and moulded in properly shaped sand moulds. It is employed for making columns, stoves, large pipes, and parts of machines. It is more brittle and hence weaker than other forms of iron. It often contains three per cent. or more of carbon.

WROUGHT IRON

Wrought iron is made from pig iron by melting it in a puddling furnace where the impurities, such as carbon, sulphur and phosphorus, are removed. Unlike cast iron, it can be altered in shape by hammering. It has much greater strength than cast iron, and is used for making bars, plates, wire, structural material and parts of machinery.

Sheet Iron is frequently coated with zinc (galvanized iron), with tin (tin plate) or with lead (terne plate).

STEEL

Steel is made by the Bessemer, Siemens-Martin, open hearth and other processes. It contains much less carbon than cast iron and more than wrought iron. It is used where great strength or hardness is needed for rails, beams, structural material, machinery and tools of all kinds. Steel wire rope is used for a multitude of purposes. Many

grades of steel are produced by the addition of small percentages of manganese, nickel, chromium, tungsten, or other metals. By sudden cooling, or "tempering" in water or oil, steel can be made of almost any desired hardness.

The chemical compounds of iron are very numerous and have many uses.

OCHERS Red, brown and yellow ochers are found in the earth, which when ground up with linseed oil and mixed with turpentine, make paints. These ochers are oxides of iron, like hematite and limonite. Burnt ochers are made by roasting raw ochers, and give a considerable range of color. Ochers and other mineral paints are prepared by chemical processes, often from the by-products of other industries.

Red ocher is often called rouge and some grades of this, washed free from grit, are used in polishing metals.

Sienna and umber are similar to ochers, but contain manganese.

Prussian Blue is an important dye containing iron.

Copperas and other sulphates of iron are used in dyeing, ink making, and for disinfecting.

Crude acetate (pyrolignite) of iron, prepared from a product of wood distillation, is used in dyeing and calico printing.

IRON PYRITE Iron pyrite or "fool's gold," a heavy brass-yellow mineral (iron bisulphide, $Fe S_2$) occurs abundantly in rocks of all ages. It sometimes, but not usually, carries gold, disseminated invisibly through it. Although it contains 46.6 per cent. of iron, pyrites is useless as an iron ore on account of the sulphur from which it cannot be successfully separated, hence its chief value is as a source of sulphur for chemical work.

Its most important commercial use is in the manufacture of oil of vitriol or **sulphuric acid** ($H_2 SO_4$), for which purpose it is roasted or burnt and the resulting sulphur dioxide gas (SO_2) is further treated. Sulphuric acid is a chemical of great importance in many industries.

Pyrites is also used in the manufacture of sulphite pulp for paper making, and in the preparation of some pigments.

MANGANESE Manganese ores are mined in Russia, Brazil, India and in smaller amount in other countries. They are used chiefly in the production of ferro-manganese and spiegel-eisen, preparations used in steel making. They are employed also in making bleaching powders such as chloride of lime, in glass making, in the manufacture of oxygen, and for various other purposes.

Pyrolusite (oxide of manganese, $Mn O_2$) and psilomelane are the chief ores.

LEAD Lead is the softest, heaviest and most malleable of the common metals, as well as one of the most easily melted. The United States, Spain, Germany and Mexico produce the most lead, but it is found to some extent in nearly all parts of the world. In this country, the most important lead mines are in Idaho, Colorado, Utah, Missouri and Kansas. We import much lead bullion from Mexico.

Galena (lead sulphide, Pb S) is the only important ore. It is a heavy lead-gray mineral with metallic luster. It often crystallizes in cubes, but the ore is generally granular-massive.

Carbonates, sulphates and other lead compounds are less common in nature.

Lead ores are often argentiferous, carrying so much silver as to be classed as silver ores. After smelting, the silver is extracted from the lead bullion.

Lead is used for making lead pipe, sheet lead and lead shot.

Type metal is composed of lead and antimony.

Solder contains lead and tin. Lead enters into pewter and other alloys.

Sheet iron coated with lead is called terne plate.

White lead is a basic carbonate of lead prepared in powdered form. Ground up with linseed oil and mixed with boiled oil and turpentine it makes the best white paint known. White lead is also employed in glazing earthenware. It is frequently mixed or adulterated with cheaper substances such as lead sulphate, barite or chalk.

Red lead (lead oxide) is used as a pigment and in making flint glass.

Litharge (another oxide) is used in preparing pigments, as a drier in making boiled linseed oil, and for other purposes.

Orange mineral is another lead pigment.

Chrome yellow (lead chromate) is used as a pigment and as a dye.

Lead acetate is used in dyeing. **Lead soap** is used in pharmacy.

ZINC

Zinc is mined chiefly in Germany, Belgium and the United States. In this country, Missouri and Kansas furnish the most ore. Some is mined with silver ore in Colorado and some comes from northern New Jersey.

Sphalerite, or blende (zinc sulphide, Zn S), called "Jack" by miners, is the important ore. It is black, brown or red in color, and often breaks with a bright cleavage. This mineral frequently occurs with ores of lead. Carbonates, silicates and oxides of zinc are found.

The crude metal called **spelter** is obtained by distilling the roasted ore. or from the mixture of various metals in the "matte" from smelters.

Zinc is used in electric batteries, in making hydrogen, in the cyanide process for the recovery of gold, and in making etched plates for printing. Sheet zinc finds various industrial applications.

Galvanized iron is made by dipping sheet iron in melted zinc, the thin zinc coating preventing rusting of the iron.

Brass is an alloy of copper with zinc.

German silver contains zinc, copper and nickel, and zinc enters into various other alloys, including some kinds of solder.

Zinc oxide or zinc white is an important pigment. It has less covering power and is less valuable than white lead.

Zinc sulphate is used as a pigment, in dyeing and as a disinfectant. Zinc chloride is used as a wood preservative.

COPPER

Copper, from an economic standpoint, is one of the most important metals. The United States is the greatest producer. Nearly all of the output is from mines in Montana, the Lake Superior district, and Arizona. Copper is produced in smaller quantities in Spain, Japan, Chile, Germany, and many other parts of the world.

The ores vary widely in composition and occurrence. Native copper in metallic particles mixed with rock is the principal ore at the Lake Superior mines. Chalcopyrite and bornite (sulphides of copper and iron) are found in many parts of the world. Chalcocite (copper sulphide) is an important ore in Montana. Malachite and azurite (carbonates of copper) are common ores in Arizona. Copper oxides and copper silicate are also found. These ores are of many colors and often occur associated with or carrying other metals such as gold, silver, lead and zinc.

The ores, after concentration, are usually roasted and smelted, and the resultant "copper matte" is separated by refiners into the various metals which it contains. Electrolytic processes of refining are largely employed.

The demand for copper has increased enormously in recent years, due to its use in electrical work, where it is mostly employed in the form of copper wire.

Copper is used also for making coins, pipes, kettles, cartridge shells, plates for engraving, for plating ships, roofing and plumbing. Compounds of copper also furnish blue and green dyes and pigments.

Brass is an alloy of copper and zinc.

Bronze contains copper and tin, sometimes with the addition of zinc. Phosphor bronze, aluminium bronze, statuary bronze, bell metal, gun metal and Britannia metal, are other alloys containing copper.

Blue vitriol or copper sulphate is the most important of the numerous chemical compounds which contain copper. It is used in the preparation of electrolytic baths, in dyes and pigments, in silver refining and as an antiseptic.

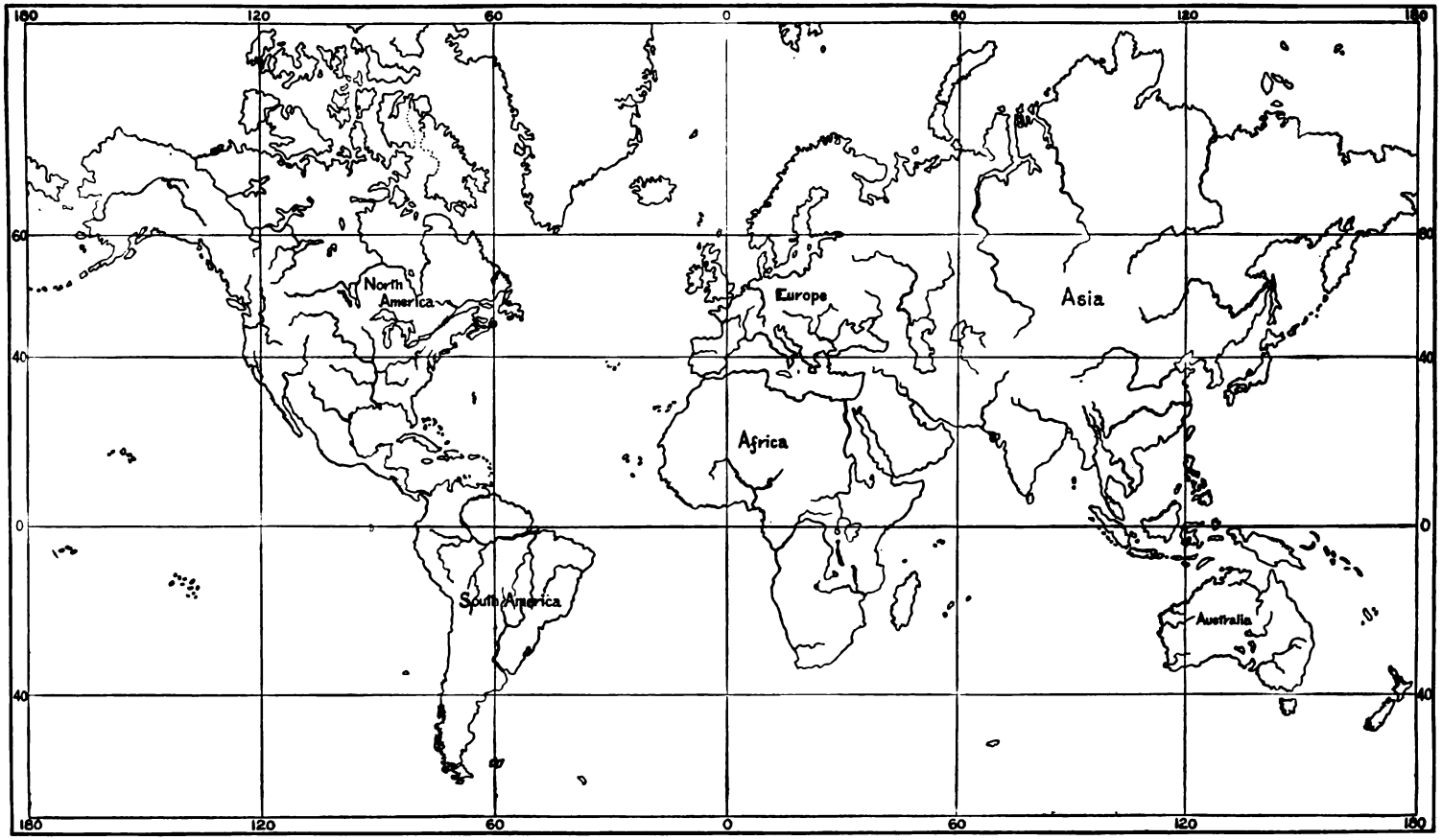
GOLD

Gold is found in nearly all parts of the world. The United States, South Africa and Australia contain the richest gold fields known. In this country, Colorado, California, Alaska and South Dakota are the largest producers.

Gold is usually in minute particles disseminated through rocks or sands. When in rock, it is ordinarily found in veins of quartz, often associated with pyrite or other sulphides.

Tellurides of gold are mined in Colorado and Transylvania.

Gold washing. Placer deposits consist of beds of sand or gravel derived from the wearing away of rocks, and contain gold in grains and nuggets. Some placers are extremely rich and from them the metal is obtained by washing. The crudest method is by rocking a small quantity of the gravel in a basin of water, the particles of gold, being heavy, sink to the bottom and are easily collected. On a larger scale, gold-bearing gravels are washed by a current of water through sluices or long wooden gutters. The gold is caught by strips of wood called "riffles," fastened diagonally in the bottom of the sluice.



GEOGRAPHIC DISTRIBUTION OF

GOLD ORES

HYDRAULIC GOLD-MINING, NEW ZEALAND.

Where there is abundant water, banks of gravel are sometimes washed down by strong jets directed on the bank through nozzles, and the gravel is carried by the water through sluices. This is termed hydraulic mining.

Gold recovery. Rocks which contain gold, after breaking, are crushed to a fine pulp with water, in stamp mills. The pulp is passed over copper plates covered with mercury which catches and forms an amalgam with the particles of gold. It is usual to separate, by concentrating machines, the heavy from the lighter part of the pulp after it passes the plates, and to treat the heavy concentrates by smelting, chlorination, or the cyanide process to recover gold which was not caught by amalgamation. Gold is soluble in a solution of cyanide of potassium and may be recovered from the solution by treatment with zinc. This process is successful with ores which contain comparatively little gold and has made possible the profitable working of such deposits as those in South Africa.

Gold is used chiefly for jewelry and currency. It is valued on account of its rarity, its beauty and because of the fact that it does not readily tarnish and is not attacked by ordinary acids. It is almost always alloyed with copper or with copper and silver. United States gold coin contains 9 parts of gold to 1 of copper. Pure gold is said to be 24 carats fine, and the best ordinarily used is about 18 carats fine. Gold is used also for making gold leaf for gilding, and in dentistry. Chloride of gold is used in photography.

PLATINUM

Platinum is a rare metal found with gold in grains, in placer washings. Russia produces ninety per cent of the world's supply and the remainder comes from Colombia. Small amounts are found in California, Wyoming, Canada and Australia.

It is used in the form of very fine wires in incandescent electric lamps to connect the terminals with the carbon filament. It is also employed in smaller amount by chemists and dentists.

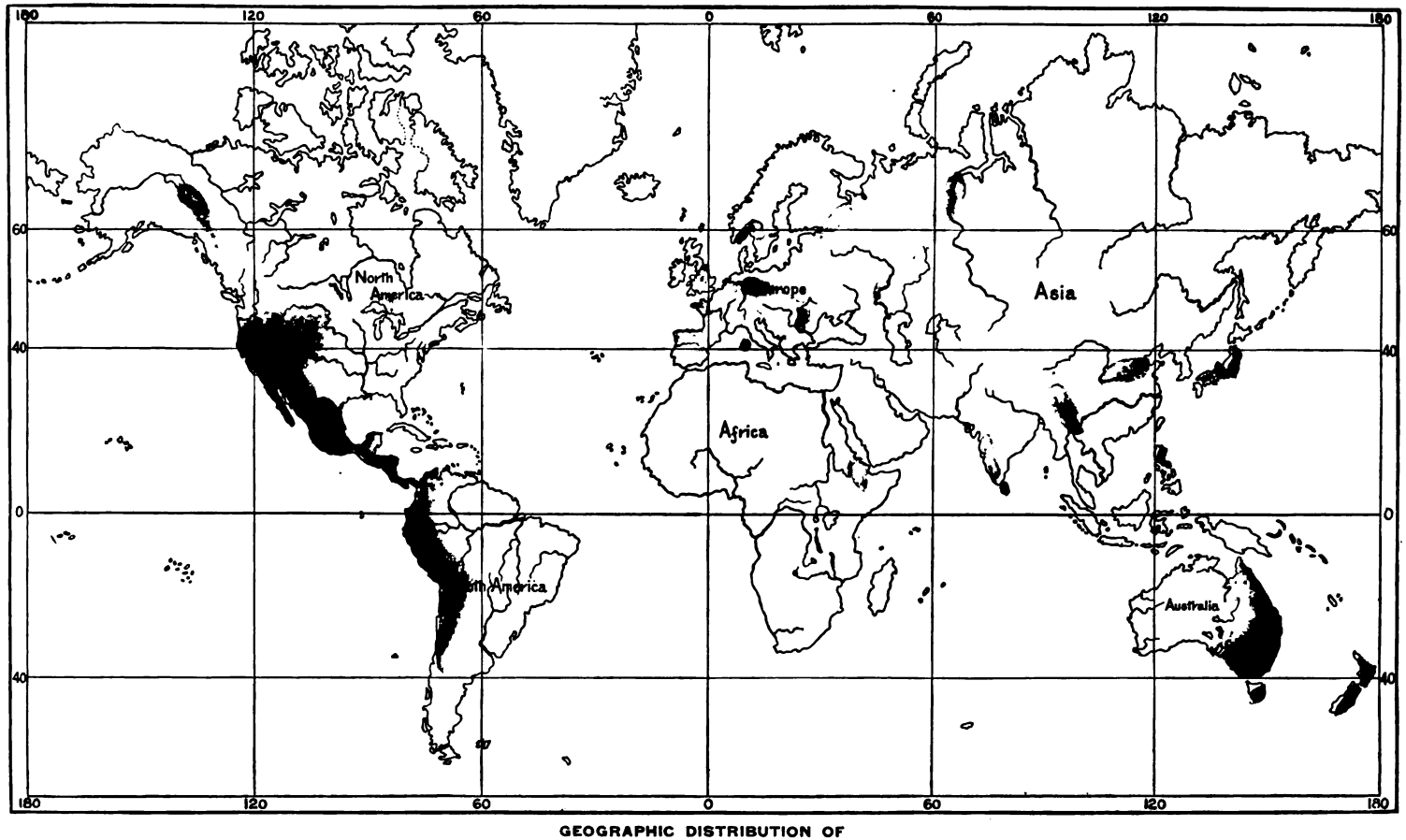
Associated with this metal is another rarer one, iridium, which is employed for the points of gold pens.

SILVER

Silver is mined throughout the Rocky Mountain and the Andes regions of America, in Australia, and to a small extent in many other parts of the world. In this country, Colorado, Montana, Utah and Idaho are the greatest producing states. Mexico, Australia, Bolivia, Chile, Peru, and Germany take rank after the United States as producers of this metal.

Argentiferous galena is the most common ore and the source of a very large percentage of the silver produced in the world. The amount of silver carried by this sulphide of lead varies greatly, but a very few ounces of silver in a ton of ore make it profitable to work many deposits of lead which could not otherwise be mined.

Ores of zinc and copper, occurring separately or associated with ores of lead and other metals, frequently carry silver. Almost all gold is found alloyed with a small percentage of silver. Pure silver occurs in small amount. Most of the silver compounds in nature are sulphides, such as argentite, pyrargyrite, stephanite and polybasite, usually containing silver



GEOGRAPHIC DISTRIBUTION OF

SILVER ORES

with arsenic or antimony. Chlorides and bromides (cerargyrite and bromyrite) are common ores in some parts of Mexico, the western United States and Australia.

Silver is extracted from ores by smelting, and refining the resultant mixture of metals; by amalgamation with mercury, or various other processes. It is made into useful and ornamental articles for the household and personal adornment, many of which are formed of some other metal or alloy covered with a thin plating of silver deposited by the aid of an electric current from a solution of cyanide of silver and potassium. The tarnish often seen on silver is due to its union with sulphur absorbed from gases formed by burning coal.

Solid silver articles, including coins, are almost never made of the pure metal, but are alloyed with copper to harden them. The price of silver has declined greatly within the past thirty years, so that at present there is less than fifty cents worth of silver in a silver dollar.

Mirrors are made by coating one side of glass with silver from a solution. Mercury was formerly used for this purpose. Silver chloride and silver nitrate are used in photography.

The mixture of various cheaper metals forms alloys such as pewter and white metal, which resemble silver in color and luster.

MERCURY

Mercury or quicksilver is found in Spain, the United States, Austria, Italy and Russia. Nearly all of the mercury obtained in the United States comes from California and a much smaller amount from Texas. One half of our production is exported to Mexico, China and Central America.

This metal is obtained from cinnabar (red sulphide of mercury, Hg S). It occasionally occurs in a pure metallic state and in a few rare compounds. It is extracted by heating (distilling) the ore. The mercury, which volatilizes readily, is condensed as the gases are cooled after passing from the furnace.

Mercury is peculiar in being a heavy metal which is liquid at ordinary temperatures. It solidifies at 38° below zero F., and boils at 675° F., a lower temperature than the boiling point of any other common metal. It is used in the extraction of gold and silver by amalgamation. It is also used in silvering mirrors, for thermometers and barometers.

Amalgams of mercury with other metals, are used for filling teeth and other purposes.

Vermillion is artificially prepared cinnabar, and this, as well as other compounds of mercury, are used as pigments.

Calomel and corrosive sublimate (chlorides of mercury) are used in medicine.

Certain mercury compounds called fulminates are dangerous explosives.

ALUMINIUM

Aluminium or aluminum is a metal which has been successfully refined for commercial use only within recent years. It is lighter than any other metal in common use and is very strong in proportion to its weight. It is readily ductile, does not easily tarnish, and is a remarkably good conductor of electricity. One of

its most important uses is as an addition to iron and steel, preventing bubbles and waste in castings. It is extensively employed as an electric conductor. It is used for the construction of some kinds of machinery, for hulls and plating for boats, cooking utensils, combs and other articles. As a substitute for stone it is used in the manufacture of lithographic plates. Alloys of aluminium with copper and other metals, forming aluminium bronzes, are used for a great variety of purposes.

Aluminium occurs very abundantly in the crust of the earth and forms numerous useful compounds.

Bauxite (aluminium hydrate, $Al_2O_3.2H_2O$) is the ore from which aluminium is extracted, and the only mineral from which it is now obtained commercially. It is a clay of peculiar composition, being a hydrate, while most clays are silicates. This ore is mined in only a few places in the world. In the United States it occurs in Arkansas, Alabama and Georgia, and in Europe in France and Ireland.

In the refining of aluminium, calcined bauxite is decomposed by a strong electric current. In this country, the power which supplies the electric current is generated by Niagara Falls, where the metal is refined.

Cryolite (fluoride of aluminium and sodium, $3NaF.AlF_3$) is a white mineral which is mined only in Greenland. It was formerly used as an ore of aluminium. At present it is of value in chemical manufacture as a source of fluorides and other salts, such as carbonate of soda, soda ash, alum, alumina, etc.

Aluminium compounds. Corundum, feldspar, and clay contain large percentages of aluminium, but are not suitable for use as ores of the metal, because they contain silica.

CORUNDUM Corundum (aluminium oxide, Al_2O_3) is, next to diamond, the hardest natural mineral. In Ceylon, and occasionally in Montana, North Carolina and other places, it occurs well crystallized and transparent, sometimes colorless or blue (sapphire) and sometimes red (ruby). These are valuable for gems. When occurring pure or nearly so, but not transparent, as it does in Canada, North Carolina, Alabama and Montana, it is ground up for use as an abrasive.

Emery. A less pure variety called emery contains considerable iron and is not quite so hard. It is extensively used as an abrasive. Emery is found at Chester, Mass., Peekskill, New York, and in Greece and Asia Minor. As abrasives these minerals are used in powder of different degrees of fineness or made into wheels, sharpening stones, cloth, or paper, and held together by some cementing material. Corundum (alundum) for abrasive purposes is also made artificially.

FELDSPAR Feldspar is found as a constituent of all granites and similar rocks. When it occurs in moderately pure masses, as it does in Delaware County, Pennsylvania, in Connecticut, New York and Norway, it is mined and used in making pottery. Feldspars are silicates of aluminium with other metals such as potassium, sodium, or calcium; the most common is orthoclase ($K_2O.Al_2O_3.6SiO_2$).

CLAY

Clay is usually a product of the natural decay or alteration of feldspar. It varies greatly in composition like the rocks from which it is derived. It is composed chiefly of hydrous silicates of aluminium, magnesium, and other metals. The purest clay, kaolin, is hydrous aluminium silicate ($2H_2O.\ Al_2\ O_3.2Si\ O_2$). It is used with other substances in making the finest pottery. Less pure clays are used in making tile, earthenware, stoneware, terra cotta, brick and firebrick.

Many clays are found in the earth, mixed with sand and grit from which they are separated by washing. This process consists of grinding and stirring the clay up in water which carries off the fine particles in suspension while the coarse part remains behind. The water containing the fine particles is conducted to settling tanks and allowed to stand till the pure clay is deposited.

Clays are fitted for making pottery in proportion to the ease with which they can be moulded and shaped when wet and their change to a hard unalterable condition when they are fired. Many kinds of clay are used in making pottery and on their nature and proportions and the heat to which they are subjected in firing depends the quality of the resulting product.

Porcelain, or china, is made from a mixture of kaolin, quartz and feldspar finely powdered, reduced to a paste with water and shaped into the desired form. The moulding is done either on a potter's wheel or in prepared moulds. The fragile "biscuit" ware is then burnt or "fired" in a kiln, after which it is decorated, a glaze applied, composed of similar materials in proper proportions to fuse to a glass, after which the articles are re-fired. The decoration is sometimes applied outside instead of under the glaze. A "salt glaze" is given to earthenware by throwing wet salt in the fire when the articles are burnt. The salt decomposes on contact with the fire, forming soda, which attacks the silica in the pottery and produces a thin glassy coating.

In the United States, Ohio, New Jersey, Pennsylvania and West Virginia are the most important pottery-making states. Fine wares are made abroad in England, France, Germany, Austria, Japan and China.

Bricks are made of the common kinds of clay containing enough sand to prevent undue shrinking. The clay is ground to a smooth paste with water, moulded into a rectangular rod and cut into lengths. Bricks are burnt in heaps or in kilns and if the clay contains iron, they assume a red color. The leading states which make brick are Pennsylvania, Ohio, Illinois, New York, New Jersey, and Missouri. The kinds which will sustain the greatest heat are called fire-brick.

Certain clays are used for "loading" paper. Others are mixed with limestone in making Portland cement.

Fuller's earth is a peculiar clay used in preparing woolen fabrics and also for filtering oils.

SLATES

Slates and shales are closely related to clays. They often contain lime, and approach clayey limestone in composition.

Slate is a very important roofing material. It is used also for writing slates, slate pencils, blackboards, mantels, etc. Pennsylvania and Vermont produce nearly all obtained in this country.

ALUM Alum is made artificially by various processes from clays and from minerals, such as cryolite and alunite. Chemically it is a sulphate of aluminium and potassium ($K_2 SO_4 . Al_2 (SO_4)_3 . 24 H_2O$). It is used in tanning leather, as a mordant in dyeing, in printing, in baking powders, in medicine, in sizing paper, in stucco work for hardening plaster, in photography, in rendering wood and fabrics fire-proof, in carbonizing wool, in bleaching, etc.

Other compounds such as aluminium sulphate are also used in the arts.

TIN Tin is not found in paying quantities in the United States. Mines in the Malay Peninsula and on the neighboring islands of Banca and Billiton produce over three-fourths of the world's supply of this metal. It is obtained in Bolivia, Australia and Tasmania and in Cornwall, England (in ancient times the only source of tin). It occurs also in China, Mexico, California, and South Dakota, but not in sufficient quantity to make its mining, at present, profitable.

The only important ore of tin is cassiterite (tin oxide, $Sn O_2$). It sometimes occurs in narrow veins through granite rocks, but is usually found as "stream tin" in small particles or pebbles in deposits of gravel from which it is separated by washing (see Gold Washing). It melts at a comparatively low temperature and is easily refined.

Tin Plate. Not being acted on readily by weak acids, nor by vegetable or animal juices, and resisting oxidation under ordinary conditions, tin is used extensively as a protective coating on sheet iron. In making tin plate, sheet iron is thoroughly cleaned by acid baths, then greased with melted tallow or palm oil and dipped in a bath of molten tin. A layer of palm oil or other material covers the melted tin to prevent contact with the air. A thin layer of tin sticks to the sheet iron which is passed through rollers to squeeze off superfluous metal and perfect the coating.

Tin plate is used for tin cans for oil, fruit, vegetables, fish, etc., for roofing and for kitchen utensils. Very large quantities are used by petroleum refiners and by canneries in general.

Tin is sometimes used for pipes and other articles of block tin.

Tin Foil is made by coating sheet lead with tin and then beating it into thin sheets.

Bronze and gun metal contain copper and tin; pewter contains tin and lead. Solder, type metal, white metal and Britannia metal all contain tin.

Tin chlorides and other tin salts are used as mordants in dyeing, and some compounds are used in coloring glass and porcelain. The United States imports metallic tin from the East Indies and from England, as well as considerable quantities of tin plate from the latter country.

ANTIMONY Antimony is produced in Germany, France, Italy, and in smaller amounts in Hungary, the United States, Japan, Servia, Borneo, Bolivia, and other countries.

The chief ore is stibnite (antimony sulphide, $Sb_2 S_3$) a lead grey mineral. Considerable amounts are also obtained from antimony oxides and from ores of lead which carry antimony.

This metal enters into many useful alloys.

Type metal contains lead and antimony, often with a little tin and bismuth; Britannia metal contains tin, antimony and copper; pewter sometimes contains antimony in addition to tin and lead.

Anti-friction metals, such as white metal and babbitt metal, consist of antimony and tin with small quantities of lead, copper, zinc, bismuth and nickel.

Tartar Emetic (antimony potassium tartrate) is used in medicine. Other salts of antimony are used as mordants in dyeing.

A sulphide of antimony is used for vulcanizing red rubber, and another compound forms a brilliant red pigment called antimony cinnabar.

BISMUTH Bismuth is found in Bolivia and Australia and in smaller quantities in Saxony, England and some other countries. It is a rare metal with a low melting point, used in fusible metal alloys. These fusible metals usually contain bismuth with lead, tin and cadmium. They are used for safety plugs for electric wiring, steam boilers, and automatic fire extinguishers.

Bismuth compounds are used in pharmacy, and in coloring porcelain and glass.

Type metal and anti-friction metals usually contain some bismuth.

NICKEL Nickel is mined principally in the province of Ontario, Canada, in New Caledonia, and in Norway. Small quantities are found in Missouri, Oregon, Idaho, North Carolina and other states and in a few parts of Europe.

Garnierite, a green mineral (a hydrous silicate of nickel and magnesium), is the most common ore. It is exported from New Caledonia and refined chiefly in France and Germany. Other compounds of nickel, such as arsenides and sulphides occur. All of these ores are generally associated with serpentine and chrome. The Canadian ore is magnetic iron pyrites (pyrrhotite, $Fe_{11}\ S_{12}$) which carries from three to eight per cent. of nickel.

A small percentage of nickel in steel increases greatly its hardness and toughness. Nickel steel is used for armor plate, parts of machinery, rails, and wire rope.

Nickel is used for electro plating and for making various white alloys.

German Silver contains copper, zinc and nickel. Nickel coins contain copper and nickel.

COBALT Cobalt is a rare metal, everywhere found with nickel. It is almost never used in the metallic state, but its compounds are used for coloring blue glass and for making pigments, (chiefly cobalt blue and smalt) for painting, printing and china decoration.

MAGNESIUM Magnesium occurs in many limestone rocks in almost all parts of the world and is found in a variety of minerals. In the metallic state it burns readily and is used chiefly by photographers, either in the form of magnesium ribbon, or in flash powders, to produce a brilliant light.

Its principal natural compounds are chlorides and sulphates, found at Stassfurt, Germany; magnesium carbonate (magnesite), obtained in Greece, Austria and California; magnesium calcium carbonate (dolomite); hydrous magnesium silicates, talc or soapstone, serpentine, asbestos and meerschaum. The metal is reduced from the chlorides.

Magnesite is used in making carbon dioxide gas for charging soda water, mineral waters and beer, and for refrigerating. After heating magnesite, the residue, called calcined magnesite or magnesia, is made into bricks or concrete and used as refractory lining for steel furnaces. Magnesia is also worked into fireproof and non-conducting coatings on steam pipes, and to a small extent in toilet powders.

When the carbon dioxide is disengaged from magnesite by sulphuric acid, **Epsom Salt** ($Mg\ SO_4.7\ H_2O$) is formed.

Magnesite and dolomite are both used in preparing sulphite liquors for use in wood pulp paper making.

Dolomite is extensively used as a building stone under the name of magnesian limestone, or simply limestone, and is harder and more durable than purer limestone. Calcined dolomite is used as a lining for iron furnaces.

Talc is a very soft mineral, easily scratched by the finger nail. It is found as talc rock (steatite or soapstone) in deposits in Maryland, Virginia, North Carolina, New Jersey, Pennsylvania and other states, and is imported from France and Italy. It is used in making bath and laundry tubs, firebrick, hearthstones, mantels, sinks, griddles, slate pencils, tailor's pencils, gas tips and other articles. When powdered it is employed for foundry facings, lubricating machinery, dressing skins and leather, in paints and toilet powders. A peculiar fibrous variety from New York is used as "filling" or "loading" in paper.

Meerschaum (Sepiolite) is a clay-like mineral found in Asia Minor. It occurs in lumps of irregular shape and is used for carving into pipes and cigar holders.

Serpentine is a greenish rock found in many parts of the world. It is often used as building stone. Verd-antique is a natural mixture of serpentine with marble, which, when polished, is used for ornamental work.

Asbestus, or asbestos, as it is usually found on the market, is a fibrous variety of serpentine (called chrysotile). It is mined in the province of Quebec, Canada, and is valuable on account of its incombustibility and as a non-conductor of heat. It is spun and woven, usually with a small quantity of vegetable fiber to give greater strength, and made into theatre curtains, mats, iron holders, building paper, etc. It is largely used as a protective covering on steam pipes and boilers. It is also used in paints. A fibrous variety of amphibole is also known as asbestos, the best being the long-fiber Italian.

Mineral Wool, sometimes called rock wool, silicate cotton or asbestos, is an artificial substance produced by melting slag and limestone, and converting the molten mixture to a very fine fibrous state by means of a steam

blast. It is used for much the same purposes as true asbestos, but cannot be spun into thread. It is extensively employed as a fire-proof packing material in walls and floors and as a non-conducting packing around boilers and steam pipes and in refrigerators.

OTHER METALS

Other metals are seldom refined, not being at present of much commercial use in the pure state. Calcium, sodium, and potassium form many useful compounds, both in their natural state and when prepared by chemical processes.

Titanium is not an uncommon and usually a very undesirable constituent of iron ores. Menaccanite is a mineral containing titanium, which although it contains a large percentage of iron is almost useless as an ore.

Rutile (oxide of titanium, TiO_2) is used in coloring false teeth.

Several rare metals are used in small amounts for making certain grades of steel. The most important of these are tungsten, molybdenum, vanadium and uranium. Salts of these metals find limited use in dyeing.

Radium, a very rare metal with very peculiar properties, occurs with uranium, and is at present used in experimental work.

Lithium carbonate is used in the preparation of medicinal tablets and mineral waters. It is prepared from certain rare minerals which in this country are found in quantity in California.

Monazite, samarskite and a few other minerals found in North Carolina, Norway and Brazil contain thorium, cerium, lanthanum and yttrium. Salts prepared from them are used in making the mantles for Welsbach and other incandescent gas burners.

ARSENIC

Arsenic occurs widely distributed in the world, but in only a few places in sufficient quantity to be of commercial value. Germany, England, Canada, the United States and Spain are the producing countries.

It is obtained from arsenopyrite (arsenical iron sulphide) and from orpiment and realgar (sulphides of arsenic).

It is used in the form of oxide of arsenic (called arsenic, white arsenic or arsenious acid) for preserving skins, for making "sheep dip" (to kill insects which harm the sheep), for rat poison, as a mordant in dyeing, in making fine grades of glassware and enamels, and in making various other arsenic compounds.

Paris Green, one of the most important arsenic salts, is used for killing the potato beetle and other insects injurious to vegetation, and, to a small extent, as a pigment.

Other compounds of arsenic are used as pigments and dyes, for medicinal purposes and in making embalming fluid. Arsenic salts are used in preparing certain of the coal-tar colors.

CHROME

Chrome ores are mined in Asia Minor and Greece. Smaller amounts come from the province of Quebec, Canada, New Caledonia, and California. There are deposits also in the Ural Mountains, in Lancaster County, Pennsylvania, in Maryland and North Carolina.

Chromite (oxide of chromium and iron, $Fe\ Cr_2O_4$) is the only ore.

Chromium is not used in the metallic state, but is chiefly valuable for its chemical compounds, particularly the pigments chrome yellow and chrome green. Various salts of chrome are used as dyes and mordants, giving a variety of colors. Chromic acid and bichromate of potash are used in tanning soft kid leather. In the tanning industry, bichromate of potash is often referred to simply as chrome.

Chrome steel contains a small percentage of chromium. It is extremely hard, being used for burglar-proof safes, hard-edged tools, etc.

BARITE Barite, or barytes, is a heavy white mineral (barium sulphate, $Ba\ SO_4$) found in Missouri, Virginia, North Carolina and Tennessee, and mined also in Germany. It is ground to a fine powder and used as a substitute or adulterant for white lead, and as a "filling" in paper. Other barium compounds have minor uses in many industries, in which artificially prepared barytes is often a by-product.

Strontium salts are prepared from strontianite (strontium carbonate, $Sr\ CO_3$) and celestite (strontium sulphate, $Sr\ SO_4$), minerals which are found in Germany, Texas and New York. Strontium hydrate (or barium hydrate) is used in sugar refining to assist the recovery of sugar from beet molasses. Strontium nitrate is used in making red fire.

POTASH Potash salts (carnallite, kainite, etc.) are found at Stassfurt, Germany. Other potash compounds are obtained by dissolving them out of wood ashes and from the burnt refuse from sugar beets. Some potash is also recovered in wool washing.

The compounds of potassium are very similar to the salts of sodium and like them are used in fertilizers, glass-making, soap-making, dyeing and a multitude of other industries.

SODA Soda (sodium carbonate) is found in small quantities in very dry regions, such as parts of California, Utah, Nevada, Hungary and Egypt.

Soda Ash is the raw commercial form in which soda salts are usually handled. It is a crude carbonate of soda, generally made from salt by treatment with sulphuric acid and subsequent carbonation. It is useful in making washing soda, baking soda (bicarbonate), caustic soda, in glass-making and many other industries.

The numerous salts of soda are useful for so many purposes that they cannot be given in detail. The carbonates are used in dyeing, soap-making, paper-making and other industries. Sodium hyposulphite is used in photography, dyeing, and tanning soft leather.

SALT Common salt includes rock salt, sea salt, and lake salt (halite or sodium chloride, NaCl). Rock salt occurs in beds or rock masses in the earth and is mined in lumps, like stone or coal. Large mines of rock salt are located in Poland; at many places in Germany and Austria; Cardona, Spain; Cheshire, England; Louisiana, Kansas, and many other parts of the world. In the Kohat District, India, there is a deposit over a thousand feet in thickness.

In this country, the greatest salt-producing states are Michigan and New York. Large quantities are also obtained in Kansas, Ohio and California. England is the greatest exporter of salt. Salt is manufactured in almost all parts of the world. Owing to its cheapness and wide distribution it is not as important an article in international commerce as staples which are more costly and less common.

When a bed of salt exists at a considerable depth, it is often found more economical not to work it by ordinary mining methods. In such cases it is usual to bore a well a few inches in diameter to the bed and pump water down the well. In contact with the salt, the water becomes a strong brine, which is pumped to the surface and evaporated.

Much of the salt of commerce is obtained from saline water. Ocean water contains about two and a half per cent. of salt. At Turk's Island and other places in the West Indies there is a large production of salt from ocean water. Some lakes, such as the Great Salt Lake and the Dead Sea, contain a larger percentage of salt than the ocean. Underground lakes or rivers from which the water is drawn through wells, in some localities yield strong brines.

The evaporation of saline water is carried on in large open tanks or vats by the natural agency of the sun and wind, or else by artificial heat in evaporating pans. Salt seldom occurs pure in nature, being generally mixed with calcium sulphate, calcium chloride, magnesium chloride, etc. The presence of these other compounds causes it to absorb water from the atmosphere.

The concentrated liquor from which salt has crystallized usually contains bromine and iodine and is sometimes worked over for their recovery. The most common commercial salt of bromine is potassium bromide. Bromides are used in medicines, in photography, and in the manufacture of red eosin (coal tar) colors.

Salt is one of the most important foods and is marketed in grains of different degrees of fineness, such as table salt, dairy salt, etc. It is used for packing meat and curing fish, on account of its preservative qualities. It is used in immense quantities in the manufacture of various chemicals, such as hydrochloric acid, soda ash, carbonate of soda, bleaching powder, chlorine, chloride of lime, etc., in the refining of silver and other metallurgical and manufacturing operations. Some of the uses of salt are due to its property of producing intense cold when mixed with ice.

SODA NITER

Soda niter (nitrate of soda, $Na\,NO_3$) is a very easily soluble mineral which occurs in immense beds in the desert region of Atacama, in northern Chile, where rain does not fall for years at a time. The deposits are found at a distance of from ten to twelve feet below the surface. The crude material is transported to extensive works on the sea-coast where the niter is dissolved out with water and recovered in an almost pure state by evaporation. In the purification, other salts and iodine are separated.

Nitrate of soda is one of the chief sources of nitrogen. It is used in making glass and in the manufacture of nitric acid, a chemical of great importance, the salts of which are useful in a multitude of ways. Well known compounds containing nitrogen, often derived from soda niter, are: fertilizers, saltpeter, gunpowder, fireworks, nitro-glycerine, dynamite and other explosives. Nitrates occur in small amounts in some caves, such as the Mammoth Cave of Kentucky.

Nitrogen is plentiful in the air, but is not in a state in which it is readily available by our present manufacturing processes. Certain bacteria which grow in enlargements on the roots of leguminous plants have the unusual property of absorbing nitrogen from the air and making it available as plant food. The culture of these bacteria is a very important part of modern soil fertilizing.

BORAX

Borax (hydrous sodium borate, $Na_2B_4O_7 . 10H_2O$) is obtained by re-crystallizing crude natural borax ("tincal") which occurs in crusts on marshes in central Asia and in California, Nevada and Oregon. Similar deposits occur in Argentina, Chile, and other parts of South America. Most of the borax used in the United States is made from colemanite (hydrous calcium borate, $Ca_2B_6O_{11} . 5H_2O$) a mineral mined in southern California. Borates are also found at Stassfurt, Germany, and in other places. Borax and boracic acid are used for the preparation of glazes for pottery and tile, for the manufacture of optical glass, in the preservation of meat, and for minor purposes.

LIMESTONE

Limestone is a rock (essentially calcium carbonate, $CaCO_3$) found in beds of great extent in all parts of the world. The purest limestones are white, but many colors are found generally caused by the presence of iron or bituminous matter. In texture limestones vary from loose to compact and from massive to fine or coarse crystalline. Many limestones are composed almost entirely of fossil shells. Limestone is one of the most important and commonly used building stones. It is employed also for roadmaking, railroad ballast, concrete, as flux in smelting, for making soda and other chemical purposes, in glass making, for preparing sulphite pulp for paper making, etc. Pennsylvania, Illinois, Ohio, Indiana, New York and Missouri are the greatest producers, although it is quarried in nearly every state.

Lime is produced by burning, or calcining, limestone in kilns. The process of calcining drives off carbon dioxide, and leaves quick lime, which is mainly calcium oxide (CaO). On exposure to air, quick lime becomes slaked by the absorption of moisture and carbonic acid. Air-slaked lime approximates to the composition $CaCO_3.Ca(OH)_2$. A solution of quick lime is used in unhairing skins, and in making soap and candles. Slaked lime is used as a fertilizer, for purifying coal gas, etc.

Common mortar is made by mixing air-slaked lime and sand with water to form a paste. As the moisture dries out, the mortar "sets" and in the course of time it hardens by the absorption of carbon dioxide (CO_2) from the atmosphere. This hardening sometimes continues for a long period, or

until all the lime is converted into calcium carbonate. Mortar is generally strengthened by mixing with it cow hair, palmetto or some other fiber.

Hydraulic limestones when calcined or subjected to heat yield a lime which will set and harden under water. These limestones all contain silicious and clayey matter and in burning form certain silicates and aluminates of lime. Hydraulic cements are unlike common lime in that they do not depend on drying for their setting, nor on carbonation for their hardening, but combine chemically with a certain amount of water and form insoluble compounds. Hydraulic cements are widely used in construction work, especially in making concrete, a mixture of broken stone with a cement mortar. Hydraulic cements are often made from other substances than hydraulic limestone, such as marls, mixtures of chalk and clay, volcanic tufa and lime, slag and lime, etc.

Portland cement is the most important of the hydraulic cements. It is prepared from mixtures of limestone, either pure or silicious, with clay. The various substances are powdered and mixed in certain definite proportions. The mixture is thoroughly burned to a clinker, which is afterwards ground to a fine powder for use.

Chalk is a peculiar soft limestone resembling white clay. Most of it comes from England.

Whiting is chalk, ground fine and prepared by washing. (See Clay Washing.) It is also prepared from some white clays. Whiting is mixed with linseed oil, to make putty, and is used as an adulterant for other white pigments in paints. Whitewash is sometimes prepared by mixing whiting with water and a little glue, and sometimes by mixing slaked lime and water. Whiting (prepared chalk or putty powder) is also used as a polishing powder.

Marble. Limestones suitable for polishing or for use in ornamental work are called marble. The term is sometimes restricted to the white crystalline varieties.

Many kinds of marble are known by the names of the localities where they are obtained. Carrara marble is the fine Italian statuary marble. Tennessee marble is a kind extensively used in this country for ornamental work. Many different kinds of beautiful marble are found in Italy. Vermont is the greatest marble-producing state in the Union. Georgia, Tennessee and New York produce large quantities. Marble is also mined in several other states. Marble dust and chips are used in the generation of carbon dioxide gas (CO_2) for charging soda water and other aerated beverages.

Mexican Onyx is a translucent limestone, with beautiful colors, found in many countries and used for ornamental purposes.

Lithographic limestone is a variety with a very fine texture, found at Solenhofen, Germany, and used in making lithographic plates.

Marl is a calcareous clay generally containing the remains of many shells and marine animals. It is sometimes used in making Portland cement and often as a fertilizer. The marl of New Jersey is composed mostly of glauconite or greensand (a hydrous silicate of iron and potassium). It is frequently phosphatic and is used as a fertilizer.

"Chloride of lime," or bleaching powder, is generally prepared by slaking lime with water and passing chlorine gas over and through it. It is used for bleaching textiles and paper pulp and for disinfecting.

Acetate of lime is used as a mordant in dyeing.

Calcium carbide is prepared by heating a mixture of chalk and coke in an electric furnace. When treated with water this substance liberates acetylene gas, a powerful illuminant.

GYPSUM

Gypsum (hydrous calcium sulphate, $Ca\,SO_4 . 2H_2O$) is a soft mineral found in nearly all parts of the world. In the United States it is mined in Michigan, Kansas, New York, Ohio and other states. A considerable quantity is imported from Canada. Beds of salt are usually found near gypsum.

Plaster is prepared by calcining gypsum, a process which consists in heating it, thus driving off some of the water which it contains. When plaster is mixed with water, they combine again to make gypsum and the minute crystals of this substance in forming, interlace and cause the plaster to "set." The purest calcined gypsum is called "plaster of paris." Wall plaster is less pure, contains sand and fiber, and does not set so rapidly as plaster of paris. Impure gypsum is used in making land plaster and other fertilizers. Powdered gypsum is used as a "loading" material in paper making.

Alabaster is a compact, pure white variety of gypsum used for ornamental purposes.

FLUORITE

Fluorite (calcium fluoride, $Ca\,F_2$) is used as a flux in the reduction of some ores, in the manufacture of opalescent glass, in the production of hydrofluoric acid and for minor purposes. It is obtained in Kentucky, southern Illinois, and at some places in Europe.

PHOSPHATE ROCK

Beds of rock containing greater or less percentages of phosphate of lime, usually associated with carbonate of lime, occur in various parts of the world. Some of these phosphatic beds consist of limestone, carrying a small percentage of calcium phosphate, and such are not available as a commercial source of phosphorus; some deposits are composed largely of bone and other organic remains, and some are of a distinctly coprolitic nature. The phosphatic character of these beds is traceable in most, if not all, cases to an animal origin.

The deposits near Charleston, S. C., are distinctly composed of organic remains and contain many shark's teeth, bones, and the remains of marine animals.

The phosphate rock of Tennessee is essentially a limestone from which much of the calcium carbonate has been dissolved.

Other phosphate beds occur in Florida, the West Indies, Canada, Estremadura (Spain), France, Germany and England.

In Canada deposits of limestone contain a crystalline mineral called apatite (a calcium phosphate).

Natural phosphates are used in the preparation of fertilizers, for which purpose they are usually treated with sulphuric acid (H_2SO_4), which converts the bone phosphate ($Ca_3(PO_4)_2$) into superphosphate (a mixture of calcium sulphate with the acid phosphate of lime, $CaH_4(PO_4)_2$), in which form it is much more easily soluble in water, and hence more available as plant food. The natural phosphates are also used as the source of phosphorus for the manufacture of matches, phosphoric acid and various compounds, such as phosphate of soda used in dyeing.

For other fertilizers see Guano, Lime, Gas Lime, Fish, Nitrate, Slag, etc. Wastes such as garbage and sewage when worked up by modern processes yield valuable fertilizers, with other products.

SULPHUR

Sulphur, or brimstone, occurs in a pure state in various parts of the world. It is found abundantly in the neighborhood of active or extinct volcanoes, and is frequently associated with beds of gypsum and limestone. It occurs impregnating the water of sulphur springs, and, in chemical combination with various metals, is an important constituent of the large class of compounds called sulphides, which embrace many of the important metallic ores. Native sulphur, pyrite and the waste calcium sulphide from alkali works are the chief sources of sulphur compounds. The island of Sicily is the greatest commercial source of native sulphur. The mines there have been worked for many hundreds of years. Sulphur is found in Italy, Japan, Hawaii and other places. In the United States it occurs in Louisiana, Nevada, California and Utah.

In Sicily it is partly purified by piling the rock in heaps and igniting it, the heat produced by the combustion of some of the sulphur melting the rest which runs down and is drawn off from the bottom of the heap. Crude sulphur is distilled to make "flowers of sulphur" and "roll brimstone."

Sulphur is commercially useful in vulcanizing rubber, for bleaching, for the manufacture of gunpowder and matches, for medicinal purposes, as a disinfectant, and for the preparation of many compounds which contain it. The most important sulphur compound and the one through which most of the others are derived is sulphuric acid, which is prepared from sulphur in much the same way as from pyrite.

Sulphurous acid is much like sulphuric and is most used in making paper pulp, in bleaching and disinfecting.

Some of the well-known compounds which are derived from sulphuric acid are: blue vitriol, copperas or green vitriol, and alum. Sulphuric acid is used in purifying petroleum, vegetable and animal oils, in the manufacture of the aniline dyes, and the very numerous chemical compounds embraced in the groups called sulphates and sulphites, the names and uses of which are too numerous to specify.

Bisulphide of carbon is a volatile liquid used as a solvent for rubber, sulphur, phosphorus, resins and oils. It is also employed as an insecticide, especially in wheat elevators.

QUARTZ Quartz (silica, $Si O_2$) is one of the most common minerals in all parts of the world. It is found in rock masses (quartzite); in sands and sandstones; also as clear, transparent crystals (rock crystal). Varieties occur of many shades of color, milky, amethyst, rose, yellow and smoky. Other non-crystalline kinds are found in great variety, such as agate, moss agate, onyx, sardonyx, chalcedony, carnelian, chrysoprase, prase, heliotrope, cat's eye, tiger's eye, jasper, flint, chert, hornstone, honestone, touchstone, buhrstone, petrified or agatized wood, etc. In addition to forming sandstones and quartzites, quartz occurs as a constituent of many rocks, such as granite. Many varieties of quartz are used in jewelry and for making ornamental articles. Rhinestones and lenses are cut from clear crystal quartz.

American rock flint is pure quartz rock which is crushed and used for pottery and glass making. It is mined in Connecticut and Pennsylvania.

Glass sand is obtained in Pennsylvania, Ohio, Illinois, West Virginia, New Jersey, Missouri and other states.

Quartz sand and ground quartz are used in sandpaper, sandsoap, polishing powders and sand blasts. Sand is used as a refractory lining in furnaces. Sand is also used in making moulds for casting metals, for making filter beds, for sanding railroad tracks, for mixing in asphalt for paving, and in cement and mortar for building.

Flint is found in irregular nodules in chalk or limestone. The supply comes from England, France and Ireland. It is chiefly used in pottery making, being ground to a fine powder, and mixed with clay and feldspar. Arrow points and knives were made of flint by primitive peoples. Flint was used with steel for making fire before the invention of matches.

Sandstone is a sedimentary rock composed of grains of quartz cemented together in a coherent mass. The cementing material is sometimes silicious when it forms a hard and durable rock. Sandstones occur in many shades of white, yellow, red and brown. They are found both loose and compact, and fine and coarse grained. They are used for millstones and grindstones, for building, road making, railroad ballast, concrete, etc. Some sandstones are crushed to make glass sand.

Pennsylvania, Ohio and New York are the greatest producers of sandstone in this country, but it is quarried in almost all the states. Pennsylvania and New York produce a variety called bluestone or flagstone, used for paving. Buhrstone is used for millstones. Honestones, oilstones, whetstones and other sharpening stones are mostly made of sandstone. Arkansas (novaculite), Michigan, Indiana, New Hampshire and Vermont produce most of these articles.

GLASS Glass is made by fusing a mixture of silica (glass sand), alkali (generally soda ash), and lime. This mixture makes lime glass.

In lead glass (flint glass), lead oxide (minium) is used in place of the lime. Sodium sulphate and potash are sometimes used instead of soda ash, and salts of other metals instead of the lime or lead oxide. Lead glass is somewhat softer and more costly than lime glass, but is generally

clearer and more brilliant. It is used for fine grades of glassware, particularly for cut glass. Artificial gems (strass) contain a very large percentage of lead. Small amounts of iron in the materials used, give a green color to glass. This is usually corrected by adding manganese dioxide to the mixture. Colored glass is made by adding salts of iron, copper, cobalt, or other metals.

The mixture of powdered materials called "glass batch" or "frit" is melted in a clay pot or tank in a furnace. Most articles of glass are blown by means of an iron tube about five feet long. A mass of molten glass ("metal") taken from the melting pot on the end of the tube, is expanded by blowing and shaped while hot into almost any desired form. The shaping is often done by blowing in moulds of clay or iron. Window glass (cylinder or sheet glass) is blown into a large bulb which is rolled to cylindrical form and then cut open and flattened out. For crown glass a bulb is blown, opened at the end and extended into a sheet by rapid rotation. Cheap glassware is blown by machinery.

Many articles of glass are not blown, but pressed in moulds, and others are made by a combination of blowing and pressing. Pressed glass is often made to imitate cut glass.

Plate glass is made by pouring the molten glass on a smooth iron table over which a roller passes making the glass of an even thickness. Later it is ground flat and polished with sand and rouge.

All glass must be annealed to prevent brittleness. This is done by slow and equal cooling either in a kiln where the process takes several days or in an annealing lehr or oven where the glass passes on travelling bands in a few hours, through a gradually diminishing temperature.

Cut glass is produced by pressing the article against a revolving grindstone and polishing on a wheel fed with emery and rouge. Glass is ornamented in other ways by staining (painting) and re-heating, by engraving with a small revolving wheel, and by etching with hydrofluoric acid.

Glass is used for a great variety of purposes, among the most important of which are window glass, mirrors, bottles, fruit jars, lamps, chimneys, globes, incandescent lamps, tumblers, dishes, lenses, tiling, etc. For skylights and places exposed to danger from fire, glass is made enclosing a network of wire.

Belgium, Austria, Germany, France, and the United States are the leading manufacturers of glass. In this country Pennsylvania, Indiana, New Jersey, Ohio, Illinois, New York, West Virginia and Missouri are the greatest glass-making states. The abundance of natural gas in certain sections, giving a cheap and desirable fuel, has greatly influenced the location of glass factories.

OPAL

Opal for gems is found in Australia, Mexico and Hungary. A few opals have been found in Idaho. Opals have almost the same composition as quartz.

Infusorial earth (diatomaceous earth or tripoli) is formed of the silicious shells of a multitude of microscopic organisms. It has essentially the same composition as opal. It is a light, porous, clay-like material found in Tripoli, Tuscany, Virginia, California, and many other localities. It is used for making polishing powders (electro-silicon), scouring soap, packing around boilers and steam pipes, as a base for fireproof cement, plaster and brick. It has been employed as an absorbent of nitro-glycerine in the manufacture of dynamite, but for this purpose is replaced by wood pulp.

GEMS In addition to the diamond, sapphire, ruby, opal and the many varieties of quartz used for gems, there are other hard minerals, mostly transparent, used in jewelry. Among these the most important are topaz, emerald, aquamarine, beryl, tourmaline, olivine, chrysolite, spinel, moonstone and turquois. In the island of Ceylon, precious stones of many varieties are found in gravel. In this country, beryl and amethyst are found in North Carolina and Connecticut, turquoise in New Mexico, Arizona, Nevada and California, sapphire in Montana, tourmaline in California and Maine, chrysoprase and kunzite in California, and garnet in Arizona, New Mexico and North Carolina.

Garnet is mined in North Carolina, Pennsylvania, New York and Connecticut in opaque masses unfit for gems. It is a trifle less hard than quartz and is an important abrasive used for making wheels, paper and polishing powder.

MICA Mica is a common mineral which occurs as a constituent of granite. It splits readily into very thin sheets and is of value commercially only when it occurs in sheets with an area of at least several square inches. India is the greatest producer of mica. There are important deposits in Canada, North Carolina, South Dakota and Virginia. Two important varieties are found, viz., clean transparent mica (muscovite) and opaque or dark colored mica (biotite or phlogopite). For panels in stove doors, and chimneys of incandescent gas lamps only the transparent kind is used. Sheet mica is also employed in electrical work for insulating. The scrap mica and trimmings from sheets are ground up for use in lubricating heavy machinery, and for making insulators and pipe covering. Ground mica is also used for giving a spangled or frosted effect to wall paper.

Isinglass is not mica, but a pure sheet gelatine prepared chiefly from the swimming bladders of fish. (See Isinglass.)

BUILDING STONES Building stones are generally quarried in the neighborhood where they are used, and only in special cases enter into general commerce. They are used for construction of walls, ornamental work, monuments, foundations, pavements (in slabs and paving blocks), curbstones, flagstones, etc. Exceptionally beautiful marbles and granites are shipped to a distance for the construction of handsome buildings, monuments, or interior decorations.

(See also Limestone, Marble, Sandstone, Slate, etc.)

Stone of the same general nature, in smaller, irregular pieces, is used in the form of rubble and crushed stone for roadmaking, concrete and railroad ballast.

GRANITE Granite is a name applied commercially to almost all igneous rocks. Typical granite is a mixture of interlocking grains of quartz, feldspar and mica. In gneiss, the same minerals are arranged in layers. In syenite, hornblende takes the place of the mica of granite. Quartz-porphyry, andesite, mica schist, diabase, diorite, basalt, trap, and gabbro are all generally included in the class of granites. The latter of these rocks are chiefly used in the form of crushed stone for paving.

In texture, granites vary from extremely fine to very coarse grained, and in color are white or grayish, red, yellow, brown or green, depending generally on the color of the feldspar. In quarrying, blocks are loosened by taking advantage of natural joints or seams and by following certain directions along which the rock splits easiest. Granite is a very hard, strong, and durable rock, susceptible of a high polish and much used for building construction and ornamental work. In this country the states producing the most granite are Massachusetts, Maine, Vermont and New Hampshire.

HYDROCARBONS The hydrocarbon group embraces coal, asphaltum, petroleum and natural gas. These have all resulted from the decomposition of organic matter in the earth. Vegetable matter has been the most important factor in their formation, fossil plants being a prominent feature of many coal deposits. In some cases, however, such as certain petroleums and asphalts, it is highly probable that they have been derived, in part at least, from marine or other animal remains.

Porous rocks, such as sandstones, limestones and shales, not infrequently contain small percentages of bituminous matter. The coloring matter of most black marble is of this nature, and was probably derived from the animals, the shells of which furnish the lime of which the rock is composed.

The form in which these carbon compounds now occur depends on the conditions under which they were deposited, and the influence of time, heat, pressure of superincumbent rocks and other agencies to which they have since been subjected.

COAL Coal is the fuel upon which modern manufactures are absolutely dependent. It is in general the result of the gradual change which has taken place during past ages in organic deposits, chiefly vegetable, and its form and composition depend upon the extent to which this change has gone on. Thus it passes from forms, such as peat and lignite, which still retain the structure of the vegetable matter, through those with less of the volatile or bituminous ingredients to anthracite, and, further, to kinds which approach graphite. Varieties are found intermediate between all the various important types.

The most important coal-producing states are Pennsylvania, Ohio, West Virginia, Alabama, Indiana, Iowa, Colorado, Kansas, Kentucky and Maryland. Deposits are worked to some extent in most of the states and territories.

There are important deposits of coal in Wales (some of which is anthracite), in England, Germany, Austria, Russia and Australia. Other deposits, many of which are mined and which may be of greater future importance, occur in Mexico, South America, South Africa, India, China, Japan and the Philippines.

Peat or turf is a transition state between unaltered vegetable debris and brown coal. It is formed in bogs and swamps by the partial alteration of leaves, moss, wood, roots, etc., in masses out of contact with the atmosphere. Beds of peat are of comparatively recent origin and contain more or less unaltered vegetable fiber. This is sometimes extracted and made into mats and packing material. Peat is sometimes made into coke and the gases derived from it in coking yield a variety of products. Peat is a common fuel in Holland, Ireland and Russia. Muck from peat beds is sometimes used as a fertilizer.

Brown Coal is a more compact variety, usually brownish-black in color. It contains considerable water and 20 per cent. or more of oxygen. Lignite is a brown coal which retains the structure of the original wood from which it was formed. Brown coal and lignite are mined in some parts of Germany and Austria, and in other countries.

Bituminous Coal, or common soft coal, generally contains from 5 to 15 per cent. of oxygen and 4 to 7 per cent. of hydrogen. There are several types of bituminous coal, the most important of which are:

Caking or Coking Coal, which becomes pasty or semi-viscid in the fire and loses its volatile gases before the combustion of its fixed carbon.

Non-Coking Coal is similar in appearance and composition to coking coal, but burns freely, without softening, or any appearance of fusion.

Cannel Coal (parrot coal, horn coal) is a compact bituminous coal which yields 40 per cent. to 60 per cent. of volatile matter. It is used in gas-making.

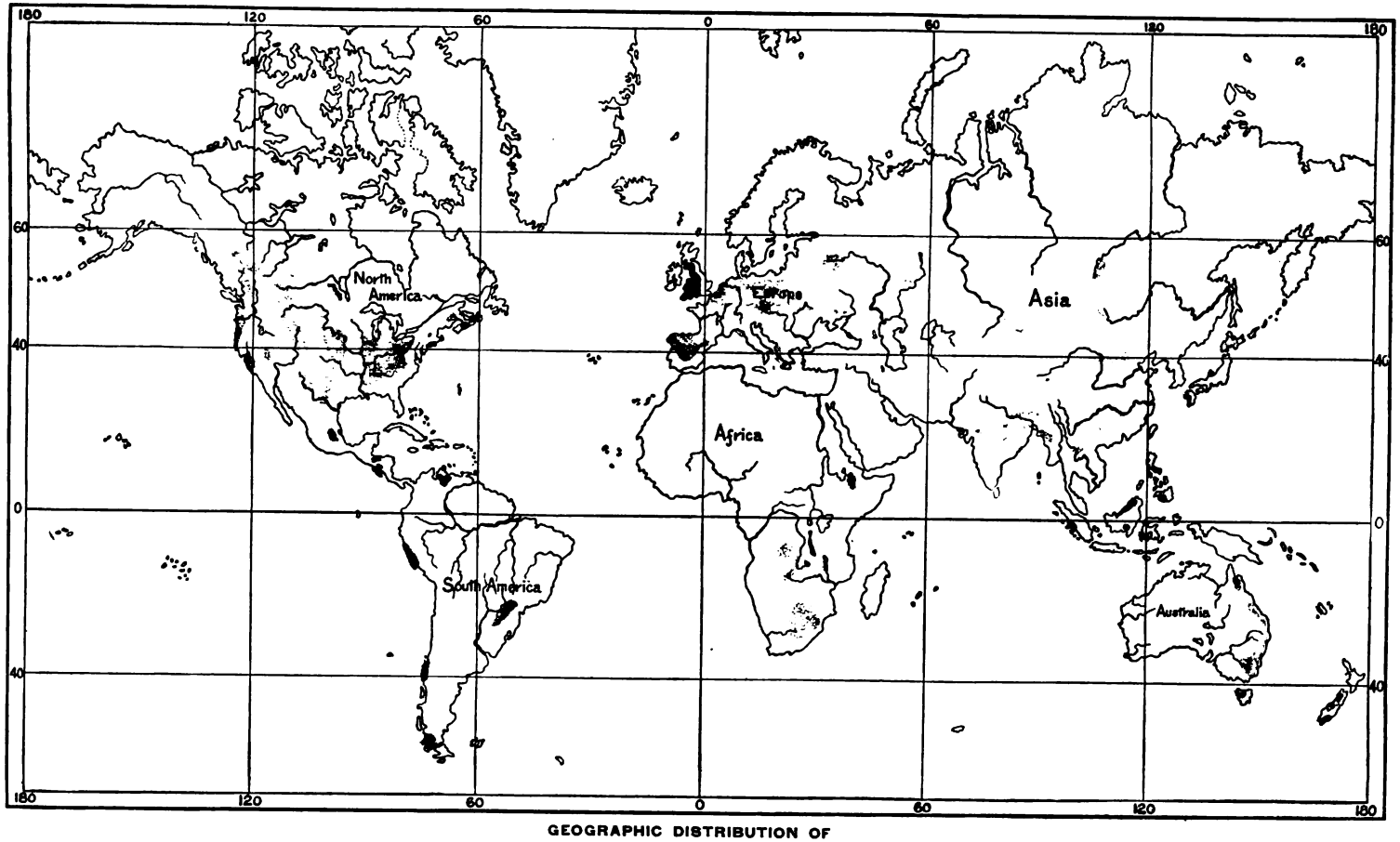
Cherry or soft coal, splint or hard coal, free-burning, binding, block, gas and steam coals are names applied to varieties of bituminous coal.

Some kinds of coal are used for special purposes for which it has been found that they are best adapted, such as coke-making, steam-raising, gas-making, smelting, etc.

Anthracite Coal is a hard coal containing a high percentage of carbon and a low percentage of volatile matter. Semi-anthracites are a stage between bituminous and true anthracite coal.

In the United States, Pennsylvania produces almost all the anthracite and leads in the quantity and value of bituminous coal, the output of this alone being three times that of Illinois, the state which stands next in importance. The value of the anthracite coal produced annually in Pennsylvania is almost equal to that of all the gold produced in a year in the United States.

In the mining of coal and its preparation for market by breaking to various sizes (known in this country as steamboat, broken, heater, egg, stove, chestnut, pea, buckwheat and rice), there is produced a great deal of



GEOGRAPHIC DISTRIBUTION OF

COAL

fine coal dust, slack or culm. This used to be piled up in great heaps near the mines and was considered valueless. Considerable of it is now being used in firing boilers, and is burned in specially constructed grates. It is also used in making coke. Much coal is separated from pyrite, clay, slate and coal dust by washing, washeries being often connected with the breakers.

Coke is a fuel prepared from coking coal by partial combustion in ovens. The heat drives off the volatile matter and the sulphur which is often contained in the coal. Coke is of great use in metallurgy, particularly in iron smelting, because of its porosity, its resistance to crushing and its comparative freedom from sulphur.

When coke is made in specially constructed by-product ovens, some of the gases which are driven off are burned under the ovens to aid in the coking, and ammonia and coal tar are recovered. In many places in this country these valuable by-products are allowed to go to waste.

Coal gas or illuminating gas is produced by the distillation of coal in retorts. The gases which come off are purified by passing through water which dissolves the ammonia which they contain, and then through slaked lime which absorbs sulphur, cyanogen and carbon dioxide. After several re-burnings the lime contains considerable calcium sulphate and is sold as gas lime for fertilizer.

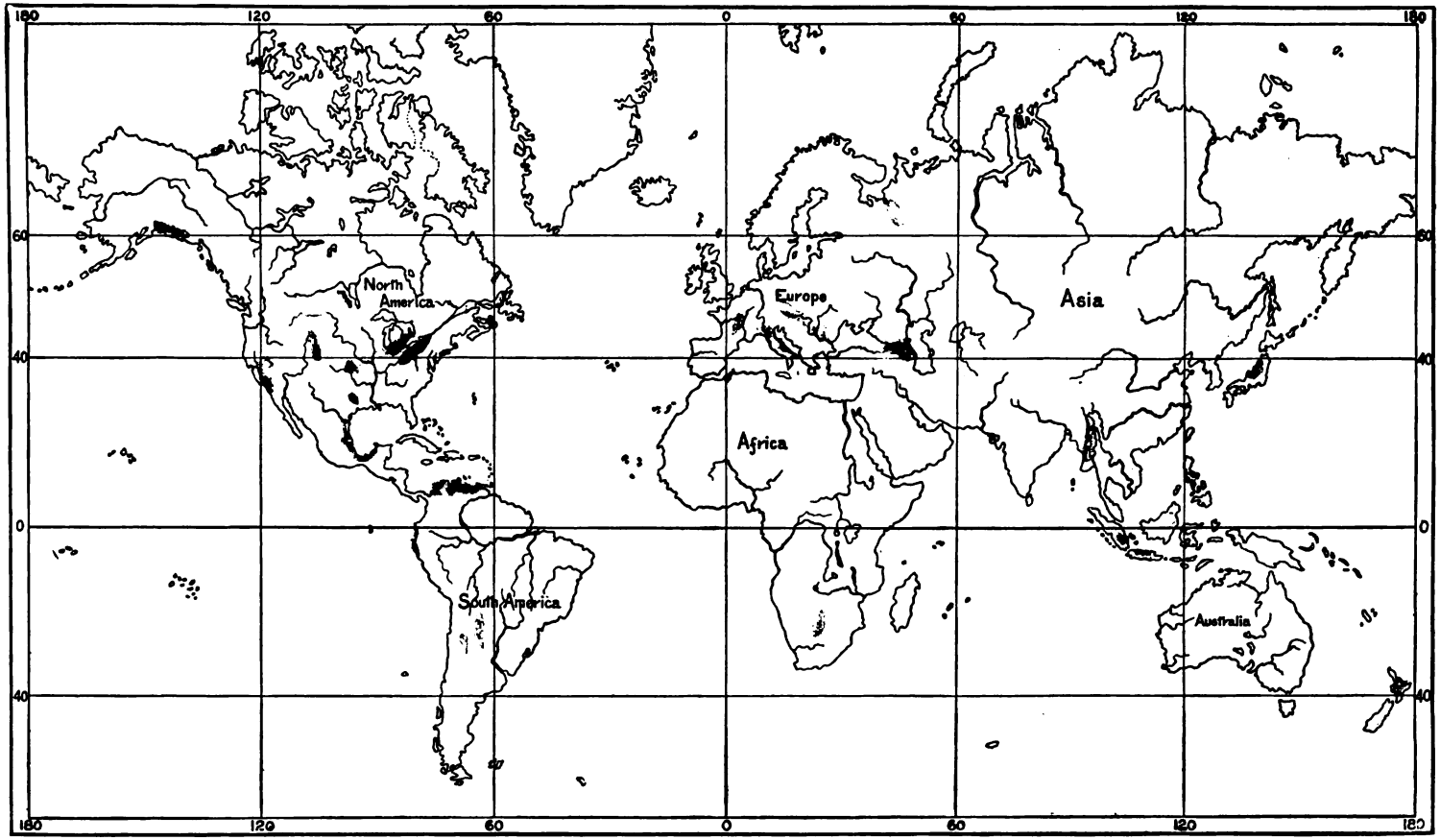
Water gas is made by passing steam over a bed of red hot coke. It is used for fuel. For illuminating, it needs to be enriched, as does also some coal gas, by mixture with benzenes or other volatile products.

The thick, viscous **coal tar** is distilled and its products re-distilled, and treated with sulphuric acid, caustic alkalis and other chemicals. They yield a great variety of useful articles, as will be seen from the accompanying diagram. There are thousands of compounds from coal tar, a list of which would simply be an enumeration of unfamiliar names. The dyes alone number several hundreds and are known as anilines, anthracenes, alizarines, eosine, etc., and are of all colors and shades. This table simply gives general groups of substances with their uses. (Ammonia is also obtained from many other sources.)

(See also Wood Distillation.)

COAL

- **GAS** — Gas for illuminating and for fuel; Gas lime and sulphate of calcium for fertilizer.
- **AMMONIACAL LIQUOR** — Ammonia for household use, chemical work, ice making; Ammonium sulphate for fertilizer.
- **COAL TAR** for Roofing Paper, Tar Paper, Tar Felt, for tarring ropes and metals, and for preserving wood.
  - **FIRST RUNNINGS and LIGHT OILS** . . . . .
    - Ammonia.
    - Crude Naptha, Benzene, Toluene, Benzoic Acid.
    - Oil of Mirbane (for scenting soap, Oil of Bitter Almonds).
    - Perfumes and Flavors (Oil of Wintergreen, Violet extract, Vanilla extract, Fruit extracts, etc.), Saccharine (300 times as sweet as sugar).
    - Benzole, Aniline Dyes, Red Ink.
    - Solvent Naptha (for dissolving rubber, water-proofing fabrics and extracting oil from seeds), Burning Naptha (for automobiles, lighting and enriching gas), Turpentine substitute, Linseed Oil substitute.
    - Pyridine (to denature alcohol).
  - **CARBOLIC and CREOSOTE OILS** . .
    - Phenols (for disinfection).
    - Carbolic Acid (for disinfection and antiseptics), Creolin.
    - Salicylic Acid, Explosives (Picric Acid, etc) Cresylic Acid.
    - Napthaline or Tar Camphor (insecticide, also for enriching gas, base for coal tar dyes).
    - Photographic Developers, (Hydroquinone, Metol, etc.).
    - Creosote (wood preservative, meat preservative).
    - Insecticides, Lubricating Oils, Burning Oils.
  - **ANTHRACENE OIL**—Coal Tar Colors.
  - **PITCH** . . . . . — Roofing; Fuel, Briquettes, Asphalt substitute, Black Varnish for metals, Lamp Black.
- **COKE** (for fuel).



GEOGRAPHIC SOURCES OF PETROLEUM

PETROLEUM

Petroleum is a liquid bituminous substance produced by the decomposition of vegetable and animal matter in the earth. It varies from a thin transparent oil to a thick viscous liquid. Petroleum is found in enormous quantities saturating beds of sandstone, conglomerate, shale, or other porous rocks. Brine is almost invariably found near petroleum, and natural gas is frequently observed. Most of the petroleum of commerce comes from the region of Ohio, West Virginia and western Pennsylvania, and from Baku, on the Caspian Sea. It is produced in Texas, Indiana, California, Colorado, Canada, and in Galicia, Sumatra, Java, Upper Burma, Roumania, Japan and Peru. The United States is the greatest producer of illuminating oils, the yield from the crude oil averaging 75 per cent., while the Russian crude oil yields only about 35 per cent. of illuminating oil. The Russian crude oil and the Texas crude oil are particularly useful as fuel oils. On distillation the Russian oil yields much napthaline.

Petroleum is obtained from wells a few inches in diameter, sunk through the earth to the porous strata where the oil occurs. The wells vary in depth from a couple of hundred feet to as much as three or four thousand feet and are bored by means of long heavy drills. Derricks built over the wells support the drilling tools. The machinery is operated by steam engines which raise the drills a few inches and drop them, their sharp chisel-like ends and heavy weight causing them to drive a hole slowly through very hard rocks. The wells are usually lined for at least a part of their depth with cast iron pipe. Wells for natural gas are bored in the same way. Wells which do not flow freely are often made to yield large quantities of oil by exploding nitro-glycerine in them. This is called "shooting" a well.

The crude oil is usually transported on land, by pumping through pipe lines. The pipes run for hundreds of miles from the wells to refineries usually located on the sea coast. From the coast, oil is shipped in tank steamers to other countries. Oils are shipped by rail in tank cars. Enormous quantities of refined oil are handled in this country and exported to all parts of the world in large square tin cans. Many foreign countries levy a heavy import duty on refined petroleum, but admit crude oil free.

Crude petroleum is refined for use by heating it in large containers. The vapors which distill off are condensed by cooling. In this way it is separated into various "fractions," some of them light and easily volatile, like gasoline, naptha and benzine; some a little heavier and less volatile, such as kerosene, headlight, and other illuminating oils; and some still heavier oils used for lubricating. The fractions are further purified by treatment with sulphuric acid and caustic soda and by re-distillation. The many grades of refined products are found useful for various purposes, such as fuel, illuminating oil, lubricating oils, oils for gas making, solvents for rubber, resins, etc., turpentine substitute, volatile oil for ice making, floor oil, and for a large number of other uses.

Vaseline, petrolatum, or other semi-solid greases are extracted from illuminating oils during the refining process. Vaseline is used in ointments and for lubricating.

Paraffine wax is separated in the purification of the lubricating oils. Paraffine is similar in appearance and in many of its properties to bleached beeswax. It is used for waxing floors, waxing paper, making candles and as a substitute or adulterant for other waxes. Ozocerite (native paraffine) is found in Galicia and is used for the same purposes, also for insulating, and waterproofing electric wires.

Lubricating oils for all sorts of machinery are prepared by mixtures of petroleum products with vegetable oils. The residuum after distillation is a thick substance similar to asphalt in its nature. It is mixed with asphalt for paving, or with coal dust is made into briquettes for fuel. When the distillation is further continued, petroleum coke results. Electric light carbons are made of petroleum coke.

ASPHALTUM

Asphaltum (mineral pitch) is a bituminous mineral substance formed by the decomposition of organic matter. It varies in consistency from liquid or viscous varieties (called mineral tar or maltha) to hard, brittle, solid asphaltums.

Petroleums change to asphaltum by oxygenation and the loss of their volatile oils. Asphaltum is found in small quantities in a state of high purity, and occurs in larger deposits mixed with earthy matter or impregnating beds of porous materials, such as clays, shales, sandstones and limestones. These latter varieties are called rock asphalts.

The most important commercial source is the Pitch Lake on the Island of Trinidad, which furnishes an asphalt containing about fifty-five per cent. of bitumen, with thirty-five per cent. of earthy matter. Asphalt is also found in Venezuela and in several of the West India islands, notably Barbados and Cuba.

In the United States, pure varieties (ozocerite, gilsonite and uintahite) are produced in Utah and California, and rock asphalts are mined in considerable quantity in California and to a much less extent in Kentucky and Indian Territory. In France and Switzerland there are large beds of asphaltic limestones which are used for paving. There are similar deposits in Germany, Italy and Spain.

The most important use of asphalt is as a paving material. Asphalt pavements are made of broken and pulverized rock and sand held together by eight to ten per cent. of asphaltic cement composed of a mixture of asphaltum and petroleum residuum. Asphalt is used as a cement between wooden paving blocks. When mixed with broken stone and sand it is compressed into asphalt paving blocks. Pure varieties are used in making black varnish for metals and leathers, for insulating, for water-proofing and for cement in construction work.

AMBER

Amber is frequently classed as a mineral among the hydrocarbons. It is a hard fossil resin, found along the shore of the Baltic Sea. Small quantities come from Sicily and other localities. It is carved into fancy articles, such as mouthpieces for pipes and cigar holders, beads and the like. The shavings and small opaque pieces are used in making fine varnish.

GRAPHITE Graphite (plumbago or black lead) is a purer form of carbon than coal. It has essentially the same composition as the diamond. It is called black lead because, like the metal lead, it will leave a mark on paper. The principal sources of supply are Ceylon, New York and Bohemia. It is also found in Canada, Mexico and some other localities.

The best or crystalline grades of graphite are used for making crucibles, lead pencils, and lubricants for chains and heavy machinery. The poorer grades are employed for stove polish, foundry facings, paint, etc. Graphite crucibles are used for melting precious metals and other substances that must be exposed to a high heat. They are made by moulding and baking a mixture of graphite and selected clay.

The lead for pencils is prepared by grinding graphite, separating the finest powders, generally by floating them away in water and allowing them to subside. The very finest powder is used for the high grade pencils. Clay is also prepared by floating and is mixed and ground with the graphite in greater or less proportion, the hardest pencils containing the most clay. After the mass is moulded in the shape of leads, it is baked in a kiln and later glued between strips of cedar which are shaped as desired.

Foundry facings are put on the surface of sand moulds to prevent the metal when cast from adhering to the sand.

Graphite is also used in glazing powder grains and shot. Graphite made artificially at Niagara Falls, by an electric process from anthracite coal or coke, is used for making electrodes, carbons, paint and foundry facings.

DIAMONDS Diamonds are found principally in South Africa. A few are obtained in Brazil and smaller numbers in India and some other parts of the world. The diamond is the hardest known substance and is composed of pure crystallized carbon (C), an element found in almost as pure a state, in the form of graphite and less pure as coal. Carbon is a necessary ingredient of all living organisms.

Clear, flawless diamonds are valued as gems on account of their rarity, hardness and high refractive power. No other substance being so hard, diamonds are cut and polished by the use of diamond dust. Amsterdam and Antwerp are the headquarters of the diamond-cutting industry.

Some diamonds are black in color and many are small, not transparent, or of such poor quality that they are useless as gems. These are used for polishing or for cutting hard substances. The black ones (carbonado or bort) are a trifle harder than transparent diamonds and are used in diamond drills. For this purpose they are mounted on the end or edge of a metal tube two or three inches in diameter. This is revolved by machinery and pressing on rocks below the earth's surface rapidly grinds or drills a hole. The cores of rock obtained from such wells give valuable information as to the nature of rocks and mineral deposits below the surface of the earth. Most wells for oil, water or brine are driven as described under petroleum.

CARBORUNDUM Carborundum is an artificial abrasive material made at Niagara Falls, N. Y., by fusing a mixture of coke, sawdust and sand in an electric furnace. Chemically it is carbide of silicon (Si C). Its hardness is greater than that of any other known substance except the diamond. Like other abrasives it is used in the form of powders of different degrees of fineness and for making grinding wheels and sharpening stones.

PUMICE Pumice is a volcanic rock, softer than most other abrasives. It is used in lump and in powder for polishing metals, stone, wood and varnish. Almost all of the pumice used comes from Lipari, an island off the north coast of Sicily.

ROTTEN STONE Rotten stone is prepared from decomposed rocks. It is a fine smooth powder, not of great hardness. It is much used for rubbing down and polishing varnished surfaces.

For other abrasives see Quartz, Corundum, Garnet, Rouge, Infusorial Earth and Putty Powder.

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